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14. ABSTRACT

Purpose: To help evaluate the Army Physical Fitness Test (APFT) and ensure a future test is associated with Soldiers' performance of common physical job requirements, the USAPHC applied a Systematic Review (SR) methodology to identify and synthesize published correlations between military task performance and physical fitness tests. Methods: A preliminary step to our SR was to identify key military-relevant tasks and physical fitness components of interest. Starting with the Army's Warrior Tasks and Battle Drills (WTBDs), twelve task categories were identified, including some tasks performed by both military and civilian occupations (e.g., firefighters, police, and athletes). Physical fitness tests were sorted into four physical fitness groups: cardiorespiratory endurance (e.g., aerobic fitness), muscle strength, muscle endurance, and flexibility. Tests of muscular strength and muscular endurance were further subcategorized into Upper and Lower Body, Core, or Whole Body regions. Physical tests included the APFT events (2-mile run, sit ups, push-ups) as well as other equipment and non-equipment physical fitness tests (e.g., jump tests, squats, sprints, pull-ups, grip tests, arm lifts, curls, and various extension machine tests). To synthesize the data, a series of meta-analyses provided pooled correlation coefficients for the twelve tasks and eleven physical fitness test groups. Results: Flexibility tests were the least frequently identified, while upper body strength tests were most frequently identified in studies that met our inclusion criteria. Correlations with aerobic tests were fairly well studied, with a few notable gaps (e.g., the Loaded March task). Pooled r coefficients for specific physical tests (e.g., run tests, push-ups, sit-ups, grip tests, and vertical and broad jump tests) were also calculated. Of the physical fitness component groups evaluated, aerobic capacity is most strongly correlated across the greatest number of military tasks (highest $r = 0.80$, average r for all tasks $= 0.53$, average r for the top 5 tasks $= 0.68$, r value range $= 0.30 - 0.80$). Of next importance, muscular strength and endurance both have strong correlations with lifting, lowering, stretcher carry and crawl (average for top 5 tasks= $r > 0.50$). Lower body strength and endurance tests (average top 5 task $r = 0.63$ and $r = 0.58$) are of similar strength to correlations for top correlations with upper body endurance (average top 5 task $r = 0.57$). Core endurance, and sit-ups specifically, are weakly correlated with most tasks (average r for all tasks= 0.33; for top 5 tasks $r = 0.38$). Conclusions: A test of aerobic capacity is fundamental for assessing Soldiers' basic physical capacity to conduct critical tasks, while sit-ups do not appear to be an important test. Muscle strength and endurance are also critical physical components. Since the current APFT does not include a measure of muscle strength or power, consideration should be given to fill this gap in future testing requirements.

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Correlations between Physical Fitness Tests and Performance of Military Tasks: A Systematic Review and Meta-Analyses

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1 Summary

1.1 Overview

The Army Physical Fitness Test (APFT) includes a 2 mile run, a 2 minute sit-up test, and a 2 minute push-up test. The APFT has been used as a standard measure of a Soldier's physical fitness and determinant of eligibility or retention since the test's inception in 1980. APFT scores have also been used in injury surveillance to help identify Army populations at greater risk of injury (i.e., those in the lower quartiles of physical fitness scores). However, despite numerous past studies, the association of the APFT to performance of required physical-demanding military tasks has never been validated. This concern has been reiterated over the last couple decades. The current supposition is that the ability to meet the APFT standards may not adequately measure a Soldier's physical capability to conduct critical military tasks, much less ensure military physical readiness in critical land combat operations. In 2012, the Chief of Staff of the Army (CSA) directed the execution of a more comprehensive scientific study of physical assessments to identify test events that would "more accurately predict Soldier performance of Warrior Task and Battle Drills." The study was also to provide a determination of the "threshold for success… for all soldiers, independent of age or gender" [1].

To help evaluate the APFT and ensure a future test is associated with Soldiers' performance of common physical job requirements, the U.S. Army Public Health Command (USAPHC) has applied a Systematic Review (SR) methodology to identify and synthesize published correlations between military task performance and physical fitness tests. Other related subject areas (e.g., association of injury to tasks and fitness tests, as well as fitness test comparisons) are being prepared as separate publications.

1.2 Purpose

Our purpose was to conduct a systematic search of the scientific literature on the association of performance tasks and physical fitness tests and synthesize the data to provide scientifically-supported recommendations regarding tests that can be used to measure physical fitness components that are most critical to basic Soldier task performance.

1.3 Results

A preliminary step to this SR was identifying key military-relevant tasks and physical fitness components of interest. Twelve task categories were identified as the key common physical tasks necessary to perform the Army's Warrior Tasks and Battle Drills (WTBDs). These included single (maximal) lifting and lowering, repeated lifting and lowering, lifting and carrying, the stretcher carry, push and pull tasks, the casualty drag, digging, marching/walking, moving fast, climbing, crawling, and combination of these (multi-activity tasks). Physical fitness tests were sorted into four physical fitness groups: cardiorespiratory endurance (e.g., aerobic fitness), muscle strength, muscle endurance, and flexibility. Tests of muscular strength and muscular endurance were further subcategorized into Upper and Lower Body, Core, or Whole Body regions. Physical tests included the APFT events (2-mile run, sit ups, push-ups) as well as other equipment and non-equipment physical fitness tests (e.g., jump tests, squats, sprints, pull-ups, grip tests, arm lifts, curls, and various machine (i.e., incremental lift) tests). To synthesize the data, a series of meta-analyses

provided pooled correlation coefficients between the twelve tasks categories and the physical fitness test groups.

Twenty-six studies met our inclusion criteria, yielding 543 task-test correlation values. Strength tests were most frequently evaluated in the identified studies. Flexibility tests were the least frequently studied. Correlations between cardiorespiratory (aerobic tests) were the most strongly correlated with the greatest number of tasks (average pooled r for all tasks = 0.53, with an average pooled r for the strongest 5 task correlations = 0.68, pooled r value range = 0.09 – 0.80). Upper as well as lower body muscular strength and muscular endurance had several strong pooled correlations (pooled r values >0.50) for lifting and lowering, stretcher carry, and crawling tasks. Lower body strength and endurance were important for the moving fast task. Core endurance was represented almost entirely by sit-ups tests; these were weakly correlated with most tasks (average pooled r for all tasks = 0.33; average of strongest 5 task correlations r = 0.38).

This systematic evaluation of decades of individual studies provides evidence that cardio-respiratory endurance (i.e., aerobic fitness) is the most essential physical fitness component required for Soldiers' performance of key physical tasks. While this finding has been suggested by some past individual studies, it is contrary to prevailing subject matter expert opinion, where aerobic fitness has been considered the least relevant physical component to military. Though this evaluation does not indicate that upper body and lower body muscle strength and muscle endurance are the *most* important fitness component for basic military task performance, the evidence indicates that they are still critical components to Army performance.

The results of this review, together with other existing data provides evidence that the current 2-mile run test is a reliable and valid field expedient test for measuring cardiorespiratory endurance. Push-ups are a reasonably reliable field expedient test for measuring muscular endurance of the upper body. Since the current APFT does not include a lower body test for muscle strength (or power), consideration should be given to fill this gap in future testing requirements. Data from this study suggest sprints or jumps tests (e.g., vertical jump or standing broad jump) may be especially worth considering. This study supports the elimination of the sit-up test; it does not support the addition of any other core or flexibility tests.

2 References

See **Appendix A** for a complete list of reference information.

3 Authority

Under U.S. Army Regulation (AR) 40-5, Section 2-19, the USAPHC is responsible for providing support for Army preventive medicine activities, and to provide Army Commands (ACOMs) the epidemiological support necessary to address force health and readiness requirements [2]. For this initiative, the USAPHC Army Institute for Public Health (AIPH) Injury Prevention Program (IPP) is providing epidemiological evidence to help better define the scientific relationship between physical fitness testing measurements and current military occupational task requirements [1, 3].

4 Introduction

4.1 Mission

The USAPHC IPP's mission is to identify injury causes or risk factors that can be used in evidence-based initiatives to prevent injuries. Strengthening the scientific evidence between correlations of physical fitness tests and military occupational task is critical element to the improvement of Soldier physical readiness. This evidence will ensure better fitness tests for measuring Soldiers capabilities as well as enhance the understanding of associated injury risk factors in order to identify interventions.

4.2 Background

4.2.1. *Policy.* U.S. Department of Defense (DOD) policy requires that "Individual Service members must possess the cardio-respiratory endurance, muscular strength and muscular endurance, together with desirable levels of body composition to successfully perform in accordance with their Service-specific mission and military specialty" [4]. The DOD policy does not define the specific tests or required thresholds for fitness measures; instead it indicates that such measures be tied to successful performance of Service-specific mission or specialty. Each Service establishes its own specific set of fitness tests and standards. In addition, a 1993 federal law [5, 6] states that the DOD:

- Shall ensure that qualification of members of the Armed Forces for, and continuance of members of the Armed Forces in, that occupational career field is evaluated on the basis of common, relevant performance standards, without differential standards of evaluation on the basis of gender;

- May not use any gender quota, goal, or ceiling except as specifically authorized by law;

- May not change an occupational performance standard for the purpose of increasing or decreasing the number of women in that occupational career field.

4.2.2. *History of physical fitness testing.*

The U.S. Army has utilized various tests of physical fitness since as early as 1919 (See **Appendix B**). Some tests have included seven or more events, including a variety of running/sprinting, jumping, crawling, grenade throwing, climbing, carrying, sit up, and push up activities. In 1957, after the Korean War the military training manual established a new test stating **"***As the reports came back from Korea, an alarming number of casualties were attributed to the inability of the U. S. soldiers to physically withstand the rigors of combat over rugged terrain and under unfavorable climatic conditions"* [7]. In 1976, a GAO report recommended that the military services develop standards for more effective performance, and that there should be no differentiation in standards between men and women [8]. In addition, a test that was easy to administer (e.g., could be administered anywhere) and required minimal equipment was desired. In 1980 the field-expedient APFT was established as the first gender-integrated Army physical fitness test [9-11]. However, the scoring system was adjusted for both gender and age groups.

Scores for the APFT events are currently based on gender- and age-adjusted standards with a maximum score of 100 points on each event; a maximum score is 300 [12-14]. The basis for the APFT scoring standards is not entirely clear. In a 1998 inquiry by the U.S. Government Accounting Office, the Army Physical Fitness School indicated that modified scoring tables were to be implemented in 1999 [15]. The revised (1998-1999) standards were to be based on a sample of actual Soldier scores where the minimum score (failing point) reflected the 8th percentile scores of the males and the females in the sample population. Maximum scores reflected the 90th percentile

of gender-based scores. Requirements were then "gradually reduced in 5-year increments as age increases" [15]. Therefore, the APFT cut-points do not represent any scientific or health-based fitness criteria, nor are they associated with a Soldier's physical capability to conduct military tasks. As this is contrary to federal law, DoD and Services have received increasing pressure to ensure scientifically defensible physical testing standards, in particular for military occupational specialties (MOS) which have previously excluded women [1, 3, 15-22].

4.2.3. *Army occupation–specific physical demands requirements.*

During the time that the APFT was initially established, Army directed studies attempted to develop gender-free occupational standards for two primary physical fitness components (cardiorespiratory endurance and muscle strength*), based on objectively determined demands of separate groups of military occupation specialties (MOS) [23, 24]. These studies were intended to establish field expedient measures of fitness related to the most physically demanding task of each MOS group for use as military entry criterion. Due to manpower concerns the tests were not employed, but aspects of muscular strength testing were later readdressed through the establishment of MOS-specific physical demands criterion based on U.S Department of Labor (DOL) lifting standards with modifications for women in the Army [25, 26]. *[Though identified as a separate component, muscular endurance was thought to overlap aspects of cardiorespiratory endurance and muscular strength, so it was not specifically addressed].

The U.S. Army currently uses MOS-specific physical demands categories (e.g., "Very Heavy" or "Moderate" amounts and frequency of lifting) in addition to a 5-digit MOS-specific index profiles that reflect basic physiological and psychological requirements for that position. These MOS-specific criteria are used to assign Soldiers to job positions once they have been accepted into Army service. As shown in **Table 4-1** and further described in **Appendix C**, these MOS-specific criteria are used in conjunction with individual Soldiers' medically-assigned 5-digit physical profiles. The MOS-specific criteria are not tests, and are not used to determine an individual's eligibility to join or remain in the military. Instead, aside from maintaining basic medical retention requirements, the APFT is used as the only routine measure of a Soldier's physical fitness, and as a determinant of eligibility or retention. It is the *defacto* test to determine readiness, though its association to military job task performance and overall readiness has never been scientifically validated [10, 15, 18, 19, 22, 27-29]. Despite national reports on this concern, no changes to the three APFT events (i.e., the 2 mile run, sit-ups, and push-ups) have occurred since its inception in 1980 [15, 19, 20, 27, 30, 31].

4.2.4. *Federal requirements for validating occupational physical standards.*

The U.S. Equal Employment Opportunity Commission (EEOC) guidelines and other legally defensible international job selection requirements are designed to ensure that job selection is not an arbitrary determination. The EEOC guidelines indicate that an employee selection procedure has adverse impact if the selection rate for any race, sex, or ethnic group is less than 4/5 (80%) of the group with the highest selection rate. Adverse impact is generally implied unless the employer can show that the selection procedures are justified because of the nature of the job. Such justification can be established through validity studies that show the selection procedure is specifically linked to the job in objective and measurable ways such as through correlational or regression analysis techniques. For example, a physical fitness test used as a selection (e.g., accession) and retention tool for employment should be demonstrated to have notable correlation to critical job elements (e.g., task performance). This correlation would demonstrate the construct of the selected test is technically valid. The tests should also be shown to be reliable (e.g., consistent results in test and re-test comparisons) as well as feasible for the work force to conduct.

Application of these legal requirements or similar requirements in other countries applied to physically demanding occupations especially in which "ineffective job performance can result in loss of life or property" [32] have been the subject of various articles and reports throughout the years (e.g., [33-39]; Canada [40-42]; Australia [43]; Britain [29, 44]). In addition to military focused assessments (e.g., [23, 29, 45-49]), perhaps even a greater number of studies have addressed

other physically demanding occupations such as firefighters [43, 50, 51] as well as police/correctional/peace officers [32, 42, 52-54]. Many of the required tasks required by these occupations are similar to those of military tasks. It is the intent of this review to construct a basic job analyses and provide scientific evidence to support the use of physical fitness tests to measure the physical fitness components most critical to basic Soldier task performance.

4.2.5. *Efforts to develop new Army tests*.

Given the lack of scientific evidence that the APFT events and its scoring are fair or appropriate determinants of Soldier's physical health or physical capacity to conduct their duties, over the last decade the U.S. Army has evaluated various new tests. A 2002 seven-event Army Physical Readiness Test (APRT) was proposed though not implemented [31]. Most recently, a 2012 five-event APRT was proposed. This proposed 2012 APRT included a 60-yd shuttle run, 1-min rower, standing long jump, 1-min push-up with no rest allowed and a 1.5-mile run for time [55]. The use of the 2012 APRT as a replacement of the APFT was considered premature, so the CSA directed the execution of a more comprehensive scientific study of physical assessments to identify test events that would "more accurately predict Soldier performance of Warrior Task and Battle Drills." The study was also to provide a determination for the "threshold for success… for all soldiers, independent of age or gender" [1]. This study is referred to as the Baseline Soldier Physical Readiness Requirements Study (BSPRRS) [1, 3, 16].

Table 4-1. U.S Army Physical Job Requirements and Determinants

Military Physical Requirement	Purpose	When/how applied	Gender/age adjustments?	Description	Authority/ Proponent
Medical Fitness Standards	Determination of an individual's medical fitness for Army duty	- Pre-entry screening (accession) [1] - As needed thereafter (retention) [1]	Yes; Medical/ health-based	Determination is based on an evaluation by a qualified medical provider IAW specified standards. Procedures result in an initial (pre-entry) medical ratings for Physical capacity, Upper body function, Lower body function, Hearing, Eyesight, and Psychiatric criteria (referred to as the "PUHLES" profile). Future injuries and medical conditions evaluated by health-care providers are used to issue temporary PUHLES profiles or to permanently change an individual's profile.[2]	Authority: AR 40-501 [a] Proponent: Medical.
MOS PUHLES Index and Physical Demands Categories	Determination of a specific job's physical demands for comparison to Soldier's medically-assigned Physical profile	- Applied for determining MOS assignment	No; Performance based	Army job- specific requirements defined by MOS-designated PUHLES index and MOS Physical Demands category (which describes amount of weights and frequency required by the job). Considered job-specific requirements that address tasks beyond the common soldier tasks/WTBDs addressed by this current study. [2]	Authority: AR 611-1 [b] DA PAM 611-21 [c] Proponent: MOS Proponent Offices; TRADOC; DA G1
Physical readiness testing	<u>Current:</u> Assessment of Soldier's physical fitness for job performance	- Entry screening (accession) [1] - Annual testing (retention) [1]	<u>Current:</u> Yes	<u>Current</u>: APFT – 2 mile run, Push Ups, Sit Ups. A uniform standard for all Soldiers/units but additional unit-specific physical tests may also be required.	Authority: AR 350-1 [d] TRADOC

[1] Can be basis for disqualification from service
[2] A Soldier's medical PUHLES profile is compared (matched) to the MOS-specific PUHLES index profiles (described below) to help determine that Soldier's MOS placement. Once placed in an MOS and unit, unit leaders are expected to train, monitor and assess individuals' physical capability and readiness to conduct their mission and tasks. Unit leaders are responsible for identifying those not capable of meeting the physical demand requirements of the MOS and following procedures for reassignment or removal.

[a] Department of the Army, AR 40-501 Standards of Medical Fitness, 2011. [56]
[b] Department of the Army, AR 611-1 Military Occupational Classification Structure Development and Implementation, 1997. [57]
[c] Department of the Army, DA PAM Military Occupational Classification Structure, 2007. [58]
[d] Department of the Army, AR 350-1 Army Training and Leader Development, 2011. [12]

4.3 Objectives.

One of the key efforts of the BSPRRS was to identify and review existing pertinent data. A substantial amount of military and occupational studies have been performed pertaining to the relationship(s) between physical fitness tests and the performance of military-relevant (physically demanding) tasks and. The use of the SR methodology was identified as a means to provide an objective thorough review and quantified analysis of the pertinent scientific and military literature. The review included an assessment of the differential effects of age and gender on these associations to the extent data allowed. Because the area of review was so broad, the USAPHC recommended four focused subject areas (see **Table 4-2**). This report documents the SR process for the identification and meta-analyses of correlations between physical fitness tests and the performance of military-relevant tasks. The results are intended to provide scientifically-supported recommendations regarding the use of certain physical fitness tests as measures of the physical capabilities needed to accomplish key military tasks.

Table 4-2. Systematic Review Subject Areas

Systematic Review Subject Areas	
1	Lab and Field Tests to Assess Physical Fitness
2	**Correlations between Physical Fitness Tests and Performance of Military-relevant Tasks**
3	Association of Military-relevant Task Performance and Injury
4	Association of Components of Physical Fitness and Injury

Status of the Systematic Review effort was provided in a USAPHC briefing to TRADOC personnel, June 2013.

5 Methods

5.1 Protocol Summary

The SR process used in this study was patterned after the PRISMA guidelines [59-61] with scientifically supported adjustments for rapid reviews [62]. As the SR methodology is ideally suited for identifying data to synthesize utilizing a meta-analysis technique, this was the intended goal of our systematic review. Application of the published SR required certain internal determinations that are documented in the following sections. The first step of our review was a preliminary assessment of information to address key questions that would define the scope, terms, and metrics of interest. Once the scope of our review was established, the next steps included applying SR procedures to identify relevant studies, evaluate and score studies, and extract relevant data. The final step involved grouping data and applying meta-analytic techniques for synthesis.

5.2 Determination of scope

Prior to initiating the systematic search of literature, project investigators conducted a preliminary assessment of readily available documents to help identify the scope of the study. This included addressing the following questions:

5.2.1 *What are the key military-relevant physically demanding tasks of interest?*

Determination of “military relevance” can depend on function of the Service (e.g., Army land forces versus Navy or Air Force) as well as the specific unit mission or individual military occupational skill (MOS) assignments. Task relevance can also change over time - especially due to changes in equipment, procedures, and the types of operational settings (from more rural to more suburban or

industrialized areas of operation). For this review, our focus was on land-based operations and tasks most commonly expected of deployed U.S. Army Soldiers. Acknowledging that MOS–specific tasks are important, this review centered on identifying physically-demanding military tasks that are considered critical to military success and also considered reasonably required of any deployed U.S. Army Soldier. These tasks are represented by Army Warrior Tasks and Battle Drills (WTBDs). WTBDs are fundamental combat skills in which all Soldiers, regardless of rank, component or MOS, must maintain proficiency to fight and win on the battlefield. Warrior Tasks are the common *individual* Soldier skills deemed critical to a Soldier's basic competency and survival. Battle Drills are the *group or collective skills* designed to teach a unit to react and accomplish the mission in common combat situations. WTBD are the foundation upon which combat training builds and are the primary focus of tactical training for both enlisted Soldiers and officers during Initial Military Training. The current list of WTBD was revised by TRADOC in March 2010 after a holistic review by subject matter experts in the combat MOS along 38,000 Soldiers surveyed from throughout the Army including drill sergeants, company commanders, company first sergeants, senior NCOs and even some junior Soldiers). That effort reduced the previous number of Warrior Tasks from 32 to 15, the number of Battle Drills from 11 to 4, and the number of associated subtasks from 235 to 76 [63, 64]. **Table 5-2** presents the current WTBD and their associated subtasks. The level of physical demand associated with the tasks and subtasks is variable, however; many require minimal or no physical exertion. Warrior Tasks 3, 5, 9, and 12 represent those considered to require the most notable physical requirements. Battle Drills physical requirements are derived from combinations of the WTs.

To further support identification of key physically demanding tasks, we considered various other military references as well as ongoing SBPRRS activities. Key tasks from these efforts and references sources are summarized in **Table 5-3.** We also considered nine common military task categories identified by a 2013 subject matter expert panel [65] (see **Appendix D**).

Articles on non-military (police, firefighter, and athlete) occupational task performance were also considered potentially relevant sources of data. **Table 5-4** provides examples of studies identified during the preliminary review that suggested these types of occupational studies could be applicable.

Table 5-5 summarizes the 12 military task categories selected for this review. The task categories reflect similar physical activities and performance goals. However, it was recognized that each task as tested in a study could include variable distances, durations, weights, and environmental conditions. These variations were considered a reasonable reflection of variations that would occur in real-world Army operations.

5.2.2. *What physical fitness components are of interest?*

"Strength, mobility, and endurance" have been identified as the three primary components of physical fitness required for U.S. military service [1, 4]. These components are not clearly defined by the military, and while definitions of key components of physical fitness can vary in scientific literature, some components are broadly recognized [65-68]. For purposes of this review, the four primary *health-related* physical fitness components of interest are depicted by **Table 5-6.** These components include cardiorespiratory endurance (which is considered the primary component of aerobic fitness or aerobic capacity), muscular endurance (which requires repeated movements for relatively short periods and thus is generally anaerobic), muscular strength (which includes short bursts of maximum force against immovable objects or maximum energy to rapidly project an object or the body), and flexibility (which can be static or include an element of time). Most literature as well as DOD policy also identifies the fifth health-based component of physical fitness as body composition (e.g., measured as Body Mass Index (BMI) or a related anthropomorphic measurement such a lean body mass (LBM)) [4, 65, 67]. However, our systematic review focuses on the first four listed components of health-related fitness and does not include body composition. Other potential *skill-related* components of physical fitness include agility, balance, power, and speed [65, 68]. While these skill-related components are not specifically included in our selected

physical fitness groups, these elements are often measured by certain muscular strength and muscular endurance tests (e.g., sprint and shuttle tests measure speed, power, and agility) [65, 67].

Correlations between muscle strength and muscle endurance fitness tests and task performance were evaluated separately for different body regions. Support for separate physical fitness evaluation of Core (trunk) muscle strength and endurance has previously been described [67]. In addition, upper and lower body function and strength are currently evaluated as separate Army fitness-for-duty and physical demand requirements for each Army MOS (**Table 4-1**, **Appendix C**) [2, 57]. Therefore, physical fitness tests of muscular strength as well as muscular endurance were separated into upper body (e.g., arm, shoulder, hand), lower body extremity (e.g., legs, thighs, feet), and core (e.g., trunk or back).

5.2.3. *What physical fitness tests are to be included?*

This review was intended to be broadly inclusive and capture data for any test that was used to measure one of the four selected physical fitness components shown in **Table 5-6** (i.e., cardiorespiratory endurance, muscular endurance, muscular strength, and flexibility).

- Cardiorespiratory endurance is characterized by tests that involve low intensity muscle contractions sustained for sufficient duration to tax the cardiovascular system. Because it these tests require aerobic as opposed to anaerobic energy mechanisms they are often referred to as aerobic fitness tests. The ideal (gold standard) measure of cardiorespiratory endurance (aerobic fitness) is the maximum rate the oxygen is used by the body which represents rate energy is supplied for long term activity. Cardiorespiratory tests include time to run specific distances, distances completed in specific times, heart rate counts of step test or ergometers, or measured maximal oxygen tests.

- Muscular endurance tests involve repeated high intensity muscle contractions for relatively short periods of time (i.e., two minutes or less) while supporting the body or external weight. Speed can be an element. There is no physiological gold standard measurement for this fitness component. The 2-minute push-up test is an example of a muscular endurance test.

- Muscular strength tests involve exerting maximal force in a single voluntary movement for a brief period (usually seconds). There is no physiological gold standard measurement for this fitness component. Tests of explosive power (such as jump tests) are often used as surrogate measures of muscular strength.

- Flexibility tests involve a measure of the length one can flex or stretch various parts of the body as far as possible [67]. Flexibility tests may be static or dynamic (ballistic). There is no physiological gold standard measurement for this fitness component. A common static flexibility test is the sit and reach.

Appendix D provides examples of physical fitness tests that have been previously identified in studies used as well as those recently recommended as field expedient measures of the different physical fitness components. While the reported reliability, validity, and field expedience of tests are critically relevant factors in the discussion of our findings and recommendations for a “new” physical fitness test, the data search and selection process did not exclude any tests due to these factors.

5.2.4. *What data measurements are of interest for this review*?

For this SR, our objective was to identify studies that presented Pearson correlation coefficients (“*r*”) between measurements of performance physical fitness tests and measurements of performance of a military-relevant task. Measures of fitness tests task performance include time

(where lesser time indicates better performance), as well as distance, repetitions, weight, and scores (where maximums indicate better performance). Both significant as well as non-significant correlation coefficients from the identified studies will be included since the reported significance is only relevant to the initial study dataset. The collection of this single data measurement (*r*) allows for the meta-analyses of a combined dataset. While other statistical methods (e.g. regression analyses) were frequently described in published studies, the resulting measurements were not amenable to our data synthesis and meta-analyses. For example, some studies reviewed evaluated prediction models for performance capability. For these studies, various combinations of anthropomorphic (e.g., BMI, LBM, age/gender) as well as fitness test measurements (run times, APFT scores) were incorporated into equations that were evaluated for best predictions of a performance outcome (usually measured by time, but also weight, repetitions, VO_2max, etc.). Such studies used multiple regression equations to identify combined sets of physical test measurements with a specific performance task (e.g., r^2) or inter-correlation values. While such studies may suggest that certain fitness measurements may be more valuable than others, the data could not be quantitatively used in this analysis.

5.2.5. *How will results be interpreted*?

The Pearson correlation coefficient is a positive or negative value of a number between 0 and 1.0 (e.g., a number between -1 and +1), that represents how close to a straight line the data lie. A value of 1 (or -1) would infer a perfect linear relationship between the two variables being investigated. The interpretation of the value that falls between 0 and 1 (or 0 and -1) is somewhat subjective, and depends largely on the type of variables being evaluated. A review of statistical guidelines especially as such applied to the social sciences suggests different scales for interpretation do share some commonalities [69-74].

Given the substantial variation expected in the fitness testing and task performance variables evaluated, a scale was derived from these examples for interpretation of the pooled *r* values in this review. **Table 5-1** presents descriptive categories for interpreting pooled r values resulting from this review's analyses. It is noted that the correlations resulting from this review represent the strength of the *linear* relationship between the tasks fitness tests and task performance, so under circumstances where there is only a weak correlation, a significant non-linear relationship may still exist.

Table. 5.1 Scale for Interpreting Pooled "r" values in this Review

Scale pooled "r" values in this review	"r" ranges cited	Qualitative descriptor of range	Source
r > 0.7 "Very Strong"	≥0.8 >0.75 >0.75 >0.70	"Very Strong" "Very good to excellent" "High" "Strong"	[69] [74] [73] [70]
r > 0.5 - 0.7 "Strong"	0.5 < 0.8 0.51 - 0.75 0.50 - 0.75	"Strong" "Moderate" "Moderate to Good"	[69] [73] [74]
r > 0.4 - 0.5 "Moderate"	0.4 - 0.6 0.3 < 0.5	"Moderate" "Moderate"	[70] [65]
r > 0.3 - 0.4 "Fair"	0.25 - 0.5 0.25 - 0.5	"Fair" "Low"	[74] [73]
r > 0.3 - 0.4 "Weak"	< 0.3 0.1 < 0.3 < 0.25 < 0.25 < 0.1	"Weak" "Fair" "Trivial" "Little or no relationship" "Weak"	[70] [69] [73] [74] [69]

Table 5-2. Warrior Tasks and Battle Drills (WTBD) and Associated Subtasks [64]

WARRIOR TASKS: common *individual* Soldier skills deemed critical to a Soldier's basic competency		
Subject Area		**Summary of Subtasks**
1	**Shoot/Maintain, Employ, and Engage Assigned Weapon System**	11 subtasks (e.g., load/unload, function check, correct malfunction, zero, engage targets) focus on M16 Rifle/M4 Series Carbine
2	**Employ Hand Grenade**	2 subtasks include perform safety check and proper techniques to employ grenade
3	**Perform Individuals Movement Techniques**	2 subtasks refer to **movements in a Fire Team and exterior movements in an urban setting (to avoid exposure)**
4	**Navigate from One Point to Another**	11 subtasks include using maps and GPS to navigate while mounted and dismounted
5	**Move Under Fire**	8 subtasks include **move under direct fire; move over, under, through, or around obstacle**
6	**Perform Voice Communications**	7 subtasks include operating communication device and how to voice messages, send reports, request medevac
7	**Use Visual Signaling Techniques**	1 subtask to demonstrate visual signaling techniques
8	**React to Chemical, Biological, Nuclear Attack or Hazard**	7 subtasks include procedure and use, and decontamination of CBRN equipment including mask
9	**Perform Immediate Lifesaving Measures**	8 subtask include evaluating casualty, conduct first aid to clear object from throat, prevent shock and restore breathing, treat burns, and control bleeding from severed extremity and **transport casualties**
10	**Perform Counter IED**	3 subtasks include identification, searching vehicles, and reaction to IED
11	**Maintain Situational Awareness/Every Soldier as a Sensor**	3 subtasks include performing surveillance and reporting intelligence information
12	**Perform Combatives**	1 subtask is to react to man-to-man contact
13	**Assess and Respond to Threats (Escalation Force)**	4 subtasks include awareness of laws, code of conduct, how to search individuals, and employ proper level of force with civilians
14	**Adapt to Changing Operational Environment**	4 subtasks include learning local cultures and interaction with media
15	**Grow Professionally and Personally (Build Resilience)**	2 subtasks include professional development and comprehensive soldier fitness
BATTLE DRILLS: *group or collective skills* designed to teach a unit to react and accomplish the mission in common combat situations		
Subject Area		**Summary of Subtasks**
1	**React to Contact**	10 subtasks include select **fighting position and** then several **of WT (e.g., react to direct and indirect fire, engage targets, mounted and dismounted; move over, through, or around obstacles**; perform voice communications; **move as a member of a Fire team**; and throw grenades) but in the context of a team situation.
2	**Establish Security**	13 subtasks include **select fighting position**, perform duty as a guard/challenge persons entering, control entry/access, and then several of the **WT** (operate communication send reports equipment perform voice communications; visual signaling, search for IED) but in the context of a team situation..
3	**Perform Actions as a Member of a Mounted Patrol**	6 subtasks include **dismount a vehicle, react to vehicle rollover, establish security; prepare vehicle for convo**y; voice communications, in context of a team situation.
4	**Evaluate a Casualty**	9 subtasks include the **WT #9**, #6 in the context of a team situation.

Table 5-3. Physically-Demanding Military (Army) Tasks Identified by NATO Countries

MILITARY	Manual tasks Lift, Carry, Push, Pull	Upright Moving Marching, Walking, Running	Other Key Activities	Sources
CANADA (2009)	▪ Lift (e.g., Ammunition box) ▪ Carry (e.g. Sand bag) ▪ Lift & carry (Jerry can)	Marching -Weight-loaded (~13 km) 3 loads: Fighting/Approach/Emergency	▪ Digging (Entrenchment dig)	[75, 76]
CANADA (2008-2010)	*Same as above, plus:* ▪ Vehicle extrication (VE) ▪ Casualty Drag (CD) (150-180 lb mannequin 20-25 m) Per observations, drag new method and about one third of 126 observed CD involved VE.	Re-Evaluation of marching: still appears a very relevant task even for non-Combat based on surveys. Almost half of respondents indicated often or more though distance < 13 k and loads heavier	Re-evaluation of digging: appears somewhat relevant task though not definitive data	[77, 78]
UNITED KINGDOM (2009)	▪ Lifting (88%) ♦ ~70% from ground; 57% to waist, 28% to shoulder, 15% to overhead; test via Ammunition box lift of 1.7 m ▪ Carry (48%) ♦ sand bag, drum, extinguisher ▪ Push -pull (3%)	▪ March (Road) (2 %)	▪ Digging (Trench Dig) (1%) ▪ Climbing (3%) ▪ Crawling (2%)	[44, 76, 79]
NETHERLANDS	▪ Lifting and carrying	▪ Walking (Loaded)		[76]
UNITED STATES (2009)	▪ Lifting/lowering (41%) ▪ Carry/load bear (30%) ▪ Pull/torque (6%) ▪ Push	▪ Walking/Running/Marching ▪ Infantry -Marching for a long distance, load bearing)	▪ Climb/descend (4%) ▪ Reach 2% ▪ Stoop 2 % ▪ (Dig/Crawl/Throw etc. -<1%)	[67, 76, 80]
UNITED STATES (2011, and 2013 Warrior Tasks and Battle tasks (WTBD)) Analysis)	*Above items but more specifically:* ▪ 'Casualty evacuation' [top ranked Battle Drill, 'life saving measures ' top warrior task) ▪ Lift and carry specific weights listed for each MOS (see Notes) based on tasks involving equipment, supplies, ammunition) ▪ Repetitive lifting	▪ Weight-loaded march (move location, security patrol) ▪ Key WTBD: 'Move under fire' & and 'React to ambush.' Includes following: → Weight-loaded run → Run (no load) – (endurance, and sprint) → Stop/start/change direction → Crawl (High & low)	*Key Common Warrior Tasks (CWT)* ▪ Crawling (low/high) ▪ Traverse pipes ▪ Jump hurdles ▪ Climb walls ▪ Stairs (up/down) ▪ Rushes and sprints ▪ Obstacle/slalom course ▪ Block/strike ▪ Employ/engage weapon ▪ Throw grenade *Key physical actions for most CWT* ▪ Squat, Lunge, Jump	[64, 81]

NOTES:

a) One of the US Army Common Warrior Tasks includes donning and basic movement in military gas mask – this is not addressed in this PT assessment

b) Weight estimates: Jerry can (10.5 pounds (lbs.) empty~41 lbs. full); Ammo box (5 lbs. empty~90 lbs. full); Sandbags, weights vary (e.g., 40, 60, up to150 lbs.)

c) Loads for marches – military loads vary from 10-150 lbs. (5-68 kg) over distances of ~3-12 miles (5-20 kg) [76]

d) Per Appendix C, current MOS Physical Demand weights [2]: Light(LT) = 10-20 lbs., Moderate (MD) = 25-50 lbs., Moderately Heavy (MH) = 40-80 lbs., Heavy (HV) = 50-100 lbs., and Very Heavy (VH) = >50->100 lbs.

Table 5-4. Examples of Military–Relevant Civilian Occupational Physical Tasks

Occupation	Manual tasks	Upright and Moving	Other Tasks	Sources
US Department of Labor industry standards	▪ Lift and carry (specific weight groups described)	▪ Standing	▪ Sitting	[35]
Firefighters*	▪ Fire hose carry (upstairs) ▪ Ladder lift/ladder extension ▪ Victim drag or carry or drag downstairs	▪ Continuous walking through all drills ▪ Walk/Run with 'load' (equipment, protective clothing)	▪ Stair climbing ▪ Ladder climbing ▪ Forcible entry ▪ Sledge hammer drive ▪ Rake	[50, 82]

Table 5-5. Military-Relevant Tasks of Interest with Related WTBDs[1]

<table>
<tr><th>Manual Movement
of equipment, supplies, people
Variables = weights, duration/distances, heights, terrain and environmental conditions, other preceding/concurrent activities</th><th>Move Body
with and without load bearing equipment
Variables = loads, distances/duration, heights, terrain and environmental conditions, preceding/concurrent activities</th></tr>
<tr><td>Lift and Lower
single (one time) maximum lift
(e.g., a common task for Battle Drills 1, 2, 4)</td><td>March/Walk
long distances
(e.g., for Warrior Task 3)</td></tr>
<tr><td>Lift and Lower
repeated lifts on off ground, vehicles
(e.g., a common task for Battle Drills 1, 3, 4)</td><td rowspan="3">Move Fast
such as to react to fire;
short distances, with and without change of direction
(e.g., for Warrior Tasks 3, 5, 12)</td></tr>
<tr><td>Lift and Carry
carry various distances
(e.g., a common task for Battle Drills 1, 3, 4)</td></tr>
<tr><td>Stretcher Carry
a specific type of the Lift and Carry task – typically evaluated as 2 person tasks
(e.g., for Warrior Task 9, and Battle Drill 4)</td></tr>
<tr><td>Push and Pull
manual movement of equipment, supplies, people not involving Lift and Carry
(e.g., a common task for Battle Drills 1, 3, 4)</td><td rowspan="2">Climb
stairs, walls, vehicles, obstacles;
includes elements scale, jump, descend
(e.g., for Warrior Tasks 3, 5)</td></tr>
<tr><td>Casualty Drag
a specific type of the Push/Pull (Drag) tasks
(e.g., for Warrior Task 9)</td></tr>
<tr><td>Dig
establish fighting position/fill sandbags
(e.g., a common task for Battle Drills 1, 2)</td><td>Crawl
high and low
(e.g., for Warrior Tasks 3, 5)</td></tr>
<tr><td colspan="2">Multi-Activity/Task (e.g., common tasks for multiple various WTBDs)
combination or series of at least 3 of the tasks/activities above; “obstacle course;” “circuit”</td></tr>
</table>

[1] The preliminary review of U.S. Army, foreign and or NATO land force sources describing key task/task elements (Table 5-3) identified lift, lower, carry, push and pull tasks; and marching and moving various distances as primary tasks. Casualty Drag (as a replacement to the Stretcher Carry) was especially highlighted. Digging was identified but less consistently as a priority, as was crawling. The following sources were also considered separately and support these task categories:

- U.S Army Physical Demands Analysis Worksheet, DA Form 5643-R: the top items listed on this Army military occupational specialties (MOS) job analysis form include: lift/lower, carry, push, pull, load bear, walk/march, climb/descend, run/rush, dig, crawl. Other elements such as swim/dive, throw, handle, finger, hammer/pound, sit, recline, reach, stand, stoop, kneel, and crouch are not included in this review [58].
- 2013 NSCA Blue Ribbon Panel: This panel of experts identified the following military common tasks: jumping over obstacles, moving quickly and with agility, running long distances, carry heavy loads, dragging heavy loads, climbing over obstacles, lifting heavy objects off the ground, and load/mount hardware [65].
- 1998 U.S Army study of over 200 MOSs: this study established databases for six types of common military tasks: lifting and carrying, lifting and lowering, push/pulling, climbing, digging, and walking/marching/running. Lifting and carrying was most common amongst all MOSs evaluated, followed by lifting and lowering. Digging, climbing, and running/marching/walking were not identified very frequently for MOS key job requirements, despite the loaded road march being a common physical requirement for most military [80].

TABLE 5-6. Four Selected Physical Fitness Components and Examples of Associated Tasks

Physical Requirement Areas[1-2]		Fitness Components[3] addressed in this Review	Associated Terms and Definitions[1-3]	Examples of Associated Physically Demanding Military Activities &Tasks[4]
ENDURANCE	A NAEROBIC ↔ AEROBIC	**CARDIORESPIRATORY ENDURANCE**	Aerobic fitness *('aerobic capacity" or stamina')* Ability to sustain high repetition low intensity muscle contractions for long periods of time (e.g., greater than 2 minutes and much longer). Ideal measure is the maximum rate the oxygen is used by the body (maximum volume oxygen or VO2 max) which represents rate energy is supplied for long term activity. Run tests for time or distance are surrogates.	• Move point to point, dismounted patrol (marching distances (miles) with a ruck) (e.g., WT3, 4; BD1) • Continuous bouts of high intensity efforts with little or no breaks (e.g., lift, carry, fill, push, pull, drag, sprint/change (e.g., direction, march) over extended time) (e.g., WT3; BD1, 3)
ENDURANCE		**MUSCULAR ENDURANCE** (Upper Body, Lower Body, Core/Trunk)	Ability to conduct high intensity muscle contractions repeatedly for relatively short periods of time (e.g., 30 seconds to less than 2 minutes). No gold standard measurement exists; measurement of number of contractions (repetitions) or time to hold contraction. Can include element of speed.	• Maintain and use material – lift & carry equipment/ammunition/ supplies (e.g., WT3; BD1, 2, 3) • Prepare fighting position - Dig/fill sand bags (e.g., BD1, 2) • Move fast under fire (over, under, around) with speed, power, agility (e.g., WT5) • Engage the enemy/react to contact (e.g.,WT12)
STRENGTH		**MUSCULAR STRENGTH** (Upper Body, Lower Body, Core/Trunk)	Strength (static or maximal) Ability to exert maximal force against a fairly immovable object for a brief period of time (e.g. less than 5 seconds) Measurement is of force (e.g., isometric tests).	• Maintain and use materiel – push/pull a heavy load (e.g., BD1) • Throw an object (grenade, smoke flare) (e.g., WT2) • Life-saving – extricate casualty (e.g., WT9; BD4)
STRENGTH / MOBILITY		**MUSCULAR STRENGTH**	Explosive Power *(used as a surrogate for strength)* Ability to expend a maximum of energy to rapidly project or move an object or the body in a single maximal effort. Measured as force/time (e.g. jump, squat, throw).	• Climb/jump (over walls, logs, fences) (e.g., WT3, 5) • Move fast under fire (over, under, around with speed, power, agility) (e.g., WT3, 5; BD1) • Engage the enemy/react to contact (e.g., WT12) • Shoot/throw grenade (e.g., WT1)
MOBILITY		**FLEXIBILITY**	Ability to stretch, flex or otherwise lengthen various body parts as far as possible (i.e., sit and reach test). Can include static or dynamic (ballistic) forms.	• Stop/change direction (e.g., while running cover to cover) with and without load (e.g., WT3, 5; BD1) • Engage the enemy/react to contact (e.g., WT12) • Climb/jump (over walls, logs, fences) (e.g., WT3, 5)

1 Mobility, strength and endurance are described in DODI 1308.1 [4]. Terms are shown in relation to associated fitness components and synonymous terms.
2 Mobility and anaerobic capacity are described as required capabilities in AR 350-1 and DA Pam 611-1 [12, 57]; they are shown in this table relative to associated components and terms. E.g., anaerobic fitness tests (as opposed to aerobic "cardio' tests) are frequently measured by elements of speed or power which are components of muscle strength and/or endurance).
3 Includes the health-based components of physical fitness not including Body Composition [65, 67, 68].
4 Includes physically demanding WTBD and activities/tasks described by other military references [67, 76, 83].

5.3 Identification of Relevant Literature

5.3.1. *Search terms.*

Based on the determination of scope and preliminary review of military tasks, a short list of key terms was identified for literature search. While specific search term approaches were adapted to address different database systems, combinations and variations of the following terms were used: "**test**, **requirement**, or **standard**," "**performance**" or "**capability**" "**functional ability**" and "**work**," "**job**" or "**occupation**," **or** "**task**" as well as "**physical fitness**" "**mobility**", and a variation of each of our selected key component terms: "**cardiorespiratory**," "**aerobic fitness**," "**muscle strength**" "**muscle endurance**" and "**flexibility**." (Because the term "mobility" was so infrequently used, the term "**agility**" was also used.)

5.3.2. *Inclusion and Exclusion criteria*.

Table 5.7 summarizes inclusion/exclusion criteria used for this review and analysis.

Table 5-7. Inclusion and Exclusion Criteria Used in Literature Review

CRITERIA	INCLUDED	EXCLUDED
Document type	• Citable studies from: • Military and non-military sources • US and non US sources	• Editorials • Presentations/abstracts • Drafts or work-in-progress documents
Dates	• $\geq$1970 - present (2013)*	• <1970
Language	• English*	• Non English
Population type	• Human*	• Animal studies • Invivo/toxicology/pathology • Biomechanical/ engineering theory
Population characteristics	• Age: Adults ($\geq$ 18 yrs $\leq$ 65 yrs)* • Healthy	• <18 (Children/infants) >65 (elderly) • Disabled/health-compromised persons
Military relevance	• Tasks described in Section 5.2	• Tasks not reasonably associated with those described in Section 5.2
*Items specifically included as filters during database searches		

5.3.3. *Data Sources.*

The goal of the literature search was to use data search sources that were broad reaching yet available at no cost to our Federal Government organization. These sources are described below.

- <u>Searchable Databases</u>: The databases used included PubMed, selected portions of EBSCO (MEDLINE, Biomedical Reference Collection, Academic Search Premier, Nursing & Allied Health Collection: Comprehensive; Cochrane Methodology Register, CINAHL & CINAHL Full Text; partial use of SportDiscus & SportDiscus Full text before access was closed), and EMBASE. The Defense Technical Information Center (DTIC) provided an online search of military reports and documents. Each subject area required determination of additional uniquely pertinent filters and search terms (for example, in DTIC, "performance capability" pulled in many equipment related evaluations).

- <u>Grey Sources</u>: Internally available documents were identified during both the preliminary review and by subject matter expert (SME) recommendations.

1.3.4. *Title and abstract review and elimination.*

To address time constraints, separate database searches were performed by two investigators and then merged into a single Endnote® file. Several documents were identified in more than one database, so these duplicates were removed. The next step involved a review of titles and abstracts to determine if the identified studies were likely to contain relevant data. This screening process was facilitated by using additional exclusion in Endnote®. Specifically, the terms “rehabilitation,” “child,” “pediatric,” “elderly,” “geriatric,” “patients,” “biomechanics,” “supplements,” “mobility and vehicle”, “mobility and aircraft,” “disabled,” “flight,” and “aircraft” were used to help further exclude many documents from the initial Endnote® compilation. Investigators conducted a sequential review process of resulting titles and abstracts: first reviewer utilized a more inclusive interpretation of criteria, while the second reviewer more critically evaluated abstracts against the exclusion criteria and the likelihood that the study would provide the requisite quantified measurements (i.e., Pearson *r* correlations).

1.3.5. *Full text review and Data extraction*.

Reports and manuscripts that were selected for full text review were reviewed and key data elements were recorded into a master Excel spreadsheet. Key elements included:

- Document information: name, author(s), year, type (technical report, journal article)
- Population information: size (n), gender, age, nationality, occupation
- Tasks (category as well as detailed description and measurement types)
- Fitness tests (types, specific tests, measurement type)
- Statistical results (e.g., Pearson correlation (*r*) values and statistical significance)

1.3.6. *Data Scoring*.

Two project investigators reviewed all full text studies using the evaluation scoring criteria shown in **Table 5-8**. The scoring criteria were derived from a review of previous SR scoring criteria and modified to most appropriately address the key elements for the types of non-experimental field studies relevant to this analysis [84-88]. The scores served as the basis for the investigators’ discussions and consensus on the final selection of included studies. This scoring process is modified from epidemiologic public health and medical studies, but serves the same fundamental purpose, i.e., to provide objective criteria for the inherently subjective assessment of the quality of scientific studies when determine evidence-based recommendations [87, 88].

Table 5.8 Scoring Criteria Used for Review of Selected Studies

Problem and Sample
1. Is there a clearly stated research question or hypothesis? (Yes = 2; No = 0)
Study Design and Methodology
2. Was the assignment of subjects to conditions randomized? Were there independent control and experimental groups? (Score 2 or 1) or Is it a study with no control or comparison group? (Score 0)
3. Is the number of subjects based on a power or sample size calculation? (Yes=2; No=0)
4. Are the subject characteristics adequately described, including the description of inclusion/exclusion criteria? (Fully met =2; Partially met=1; Not met= 0)
5. Does the experimental design and protocols employed control for potential confounding factors? (Does the experimental approach effectively isolates the mechanisms or factor of interest?) (Yes =2; No=0)
6. Were the methods described in sufficient detail for others to repeat the study? (Yes=2; No=0)
Data Presentation and Statistical Analysis
7. Are relevant confounders (covariates) controlled for during subject selection and/or in the statistical analyses? (Fully met =2; Partially met=1; Not met= 0)
8. Are the statistical techniques used appropriate for the experimental design? (Yes=2; No=0)
9. Are results presented using appropriate units (absolute unit change vs % change)? (Yes=2; No=0)
10. Are estimates of random variability for main outcome variables provided, and is statistical significance reported? (Yes=2; Partially Met= 1; Not met= 0)
Total Score
Explanation of criterion scoring: Criterion Fully met = represents ideal example of criterion Partially met= addresses criterion but not most ideal example Not met = poor example/does not address criterion at all
Criteria reflect adapted modification from previous public health SRs [84-86]

5.3 Data Analyses

The objective of this review was to determine the overall strength of the correlations between various physical fitness test groups and performance measures of key common military tasks. Ideally, this determination would be drawn from a quantitative synthesis of Pearson correlation coefficient data. Data from the selected studies were extracted and grouped into identified task categories (per **Table 5-5**) and physical fitness test groups (**Table 5-6**). Meta-analysis techniques using Hedges-Olkin methods were used to calculate overall pooled correlation coefficients (pooled Pearson's *r* values) for each task-test combination [89]. This method utilizes the total number of studies as well as each original study's correlation (r) and sample size to calculate the pooled correlation coefficient. For task-test combinations with only a single study, a pooled *r* would not be calculated. Separate male and female data were evaluated separately for task-test combinations when there was sufficient gender-specific data.

6 Results

6.1 Relevant Data Identified

6.1.1. *Literature review.*

The literature search was initiated on 15 January 2013 and retrieval continued through 8 February 2013. As summarized in **Table 6-1**, the combined search of all data bases resulted in over 17,000 titles of potentially relevant studies. After eliminating duplicates and applying inclusion/exclusion criteria to the titles and abstracts, 273 publications were identified as requiring a full text review. Of these, 33 studies were selected for data extraction and independent scoring by two investigators. Investigators discussed their scoring of the 33 identified studies, and came to a consensus for each. **Appendix E** contains the extracted data and rankings for these 33 studies. Of the 33 studies evaluated, six were eliminated because study procedures and statistical methods did not yield applicable correlation coefficients (i.e., studies utilized multiple regression models). In addition, two of the studies described the same data, so one of the studies was eliminated.

6.1.2. *Studies selected.*

Table 6-2 presents the summary of the resulting 26 studies selected for our analyses. These studies reflect a broad variety of sources (eight U.S. military, six foreign military, seven U.S. and two non-U.S. firefighter and police studies, and four other civilian/athlete studies). While the quality of these studies varied based on the scoring criteria, each provided adequate documentation of study purpose, methods, and analytical approach for the resulting data to be considered appropriate for this review.

Table 6-1. Systematic Selection of Relevant Studies

Step of Process	Number Articles/Studies
# Literature search finds	**17,404**
# Duplicates removed	*-3,472*
# Title/Abstracts reviewed	**13,932**
# Exclusion removals	*-13,743*
# Resulting Full-text from literature	**189**
# Additional from grey sources	+84
# Total full-text reviews	**273**
# Excluded after full review	*-240*
# Studies selected (data extracted, quality scored)	**33**
# Removed (study / data limitation)	*-6*
# Removed (data duplication)	*-1*
# Total Studies (data used)	**26**

Table 6-2. Full Text Selected Studies*

Study population	Military: Study (first author, year)	Military: Quality Score	Military: Population	Firefighter/Police: Study (first author, year)	Firefighter/Police: Quality Score	Firefighter/Police: Population	Other: Study (first author, year)	Other: Quality Score	Other: Population
USA	Mello, 1988 [90]	++++	28 Army (M)	Schonfeld, 1990 [91]	+++	20 Firefighters (M)	Barnes, 2007 [92]	++++	29 Volleyball (F)
	Knapik, 1999 [93]	+++	11 Army (MF)	Rhea, 2004 [50]	+++	20 Firefighters (MF)	McBride, 2009 [94]	++	17 Football/athlete (M)
	Pandorf, 2001 [95]	+++	12 Army (F)	Williford, 1999 [96]	++	91 Firefighters (M)	Harman, 2008 [28]	++	32 Healthy civilian (M)
	Beckett, 1988 [97]	+++	102 Navy (MF)	Myhre, 1997 [98]	++	279 Firefighters(MF)	Kraemer, 1998 [99]	+	123 Healthy civilian (F)
	Wright, 1984 [100]	++	272 Army (MF)	Michaelides, 2011 [101]	++	67 Firefighters (M)			
	Robertson, 1985 [102]	++	45 Navy (MF)	Michaelides, 2008 [103]	++	38 Firefighters (M)			
	Aanstad, 2011 [104]	++	42 AF/Guard Cadets (M)	Arvey 1992 [105]	+++	276 Police (MF)			
	Eliminated: Frykman, 2000 [106] *as was same data as Pandorf 2001* [95]*; Vickers 2008* [107] *and 2009* [108] *due to inapplicability of methods and statistical analyses.*			*Eliminated: Sothman 2004* [34]*, Davis 1982* [82] *due to inapplicability of methods and statistical analyses*					
Non-US	Stevenson, 1989 [109]	++++	16 CAN (M)	Phillips, 2010 [110]	++	38 Firefighter(M) AUS			
	Bilzon, 2002 [79]	+++	93 UK (MF)	Williams-Bell, 2009 [111]	+	41 Firefighter(MF) CAN			
	Stevenson, 1992 [112]	++	132 CAN (MF)						
	Deakin, 2000 [113]	++	623 CAN (MF)						
	Singh, 1991 [75]	++	116 CAN (M)						
	Thebault, 2011 [114]	++	19 FRA (M)						
	(Eliminated Rayson 2000 [29] *due to inapplicability of methods and statistical analyses)*								
Total= 26	**13 Military Studies** (7 USA, 6 Non-US)			**9 Firefighter/Police Studies** (7 USA, 2 Non-US)			**4 Other Studies** (athlete or healthy adults)		

* See details of extracted data in **Appendix D.**
>15 on scoring criteria = ++++, ≤15 - 13 = +++, <13 - 10 = ++, 9.5 = +
M = Male, F = Female; AF = Air Force; CAN = Canada; UK = United Kingdom; FRA = France; AUS = Australia

6.2 Grouped Data

Correlation data for the twelve (12) selected categories of military tasks and physical fitness test measurement were grouped by component of physical fitness (e.g., cardiorespiratory muscle strength and endurance, and flexibility tests). Muscle endurance and strength tests also were grouped by body regions (Upper, Lower, or Core). Since one study used total combined APFT scores as a measurement for fitness tests, this was grouped as a "Whole body – All" fitness group since it represented both cardiorespiratory and muscle endurance components. In addition, one study provided measurements from isometric tests involving both the arms and legs; these 'all limb' strength tests were also grouped separately and referred to as "Whole Body - Strength tests." **Table 6-3** summarizes the number of studies that provided Pearson correlation coefficients for the different combinations of task categories and test groups. **Table 6-4** summarizes the number of studies that provided a minimum of two separate datasets for both men and women to support a potential evaluation of gender differences in correlations of task and test combinations. **Appendix F** provides the final set of extracted, grouped and sorted data (performed in Excel®). The final data extracted included **543** distinct task and test correlation values, which are sorted by task category, and then type of fitness test group (component), body region, and then by specific types of tests. Correlations from each study were specifically evaluated to ensure data sets were grouped and compared consistently. Specific considerations are described below:

- Task variables. About half of the 26 studies were performed by non-U.S. military and civilian groups. About one half of the studies (i.e., thirteen) were conducted with non-military study populations, the majority of which were firefighter study groups. As noted in Section **5.3,** tasks amongst studies varied in distances, weights, and time, and environment. Several of the firefighter duties and tasks most commonly tested included the combined 'multi-activity' or obstacle course of a series of the tasks, which is considered a close parallel to many of the military activities (e.g., 'tasks'). For example, the firefighter lift and carry and lift and lower tasks involved objects that were unique to firefighter (e.g., hose coils/rolls, fire pumps, and ladders). The weights and sizes of these objects can reasonably be compared to the numerous variations of military-unique objects including sandbags (of varying weights), ammunition boxes, and varying sizes and weights of boxes and bags, tires, and ruck sacks. **Table 6.5** provides an example of variables as they were reflected in tasks measured in different studies. Other variables included the load or equipment worn by the person conducting the task, the amount of other activity preceding the task, the learning curve, and environmental conditions.

- Negative versus Positive Correlations. Depending on the individual study design and measures, either a positive or a negative correlation may have been reported. For example, if a measurement for task performance was time (less time equaling better performance), and the correlation was made to a timed 12-minute distance run (measured as maximum distance), the correlation was reported as negative. To ensure consistent comparisons, the reported correlations were standardized so that in all cases a positive *r* value reflected both better performance on a test and better performance on a task. As is the given example, taking the absolute value of the reported r provided this standardization. **Table 6.6** provides additional examples. Care was taken to ensure that if a study showed that "better" performance of a physical fitness test was in fact a negative predictor of the performance measure of the military task.

- Specific Fitness tests identified. **Table 6-7** provides a summary of the physical fitness tests evaluated in the selected studies along with the physical component the groupings used for this review.

Table 6-3 Identified Datasets* with Correlations between Military Task Categories and Fitness Test Groups

Task Category	Cardio Respiratory	Muscular Endurance			Muscular Strength				Flexibility	Overall	*Total # Task-Fitness datasets*
		UB	LB	CR	UB	LB	CR	WB	FLX	WB-All	
Lift & Lower (Single)	5	11	3	4	10	7	1	0	3	0	*44*
Lift & Lower (Reps)	5	6	1	3	11	6	5	0	0	0	*37*
Lift & Carry	4	17	4	8	19	7	4	0	1	0	*64*
Casualty Drag	7	11	5	6	9	5	3	2	1	0	*49*
Stretcher Carry	7	15	0	9	22	5	1	0	0	0	*59*
Push/Pull	2	9	4	4	7	5	2	0	1	0	*34*
Loaded March	1	4	18	0	5	19	2	1	0	0	*50*
Move fast	8	9	2	7	5	13	0	0	3	1	*48*
Climb	4	8	3	3	5	3	1	2	1	0	*30*
Crawl	2	5	0	5	5	2	1	0	0	1	*21*
Dig	2	5	1	4	9	3	4	0	0	0	*28*
Multi-Activity	9	17	10	10	15	9	1	2	5	1	*79*
*Total # Task-Fitness Component datasets /**(Total # studies)***	*56 (**14**)*	*117**(17)***	*51**(4)***	*63**(15)***	*122**(18)***	*84**(17)***	*25**(4)***	*7**(2)***	*15**(5)***	*3**(1)***	*543**(26)***

** NOTE: several studies reported multiple correlations values; for some studies this includes reporting different measures for the same task to test combination (e.g. 2 values for upper body endurance tests to the climb task)*
UB= Upper Body; LB= Lower Body; CR = Core/Trunk (in spreadsheets =TR for Trunk); WB= Whole Body (all Limbs) WB- All = Whole Body All e.g. total APFT score

Table 6.4 Tasks and Fitness Test Groups with at Least Two Separate Male and Female Correlations Sets

Task Category	Cardio Respiratory	Muscular Endurance			Muscular Strength				Flexibility	Overall
		UB	LB	CR	UB	LB	CR	WB	FLX	WB All
Lift & Lower (Single)					✓					
Lift & Lower (Reps)	✓	✓			✓					
Lift & Carry	✓			✓	✓	✓				
Casualty Drag										
Stretcher Carry	✓	✓	✓	✓	✓	✓	✓			
Push/Pull										
Loaded March					✓	✓				
Move fast										
Climb										
Crawl	✓	✓		✓	✓	✓				
Dig	✓	✓		✓	✓	✓				
Multi-Activity		✓			✓					

UB= Upper Body; LB= Lower Body; CR = Core/Trunk (in spreadsheets =TR for Trunk); WB= Whole Body (all Limbs) WB- All = Whole Body All e.g. total APFT score

Table 6.5 Example Task Descriptions and Variables on Selected Studies

Task	Performance Measurement
Casualty Drag	
Drag 180lbs (82 kg) mannequin for 15.7 meter	Amount of time
Drag 177lbs (80kg) mannequin for 30 meter	Amount of time
Run 50m, drag 80kg (177lbs) dummy by webbing for 50m	Amount of time
Drag 154 lbs (70 kg) mannequin for 100 m	Amount of time
Drag 175 lbs (79.5 kg) mannequin for 30.5 m	Amount of time
Drag 180lbs (82 kg) for 25.5 m across level grass	Amount of time
Lift and Carry	
Lift and carry 68 lbs (31 kg) box for 51 m	Maximum total weight
Lift and carry 40 lbs (20 kg) sandbag for 50 m in set time	Maximum number of bags
Lift and carry 22 lbs (10 kg) hose roll 16 m, six times	Amount of time
Lift and carry 36.3 lbs (16 kg) hose coil up 5 flights	Amount of time
Lift and carry two 46 lbs (21 kg) jerry can for 35m, three times	Amount of time
Lift and carry 22.7 kg sand bag for 50m, eight times	Amount of time
Lift and carry 43lbs (19.5 kg) hose roll 75 ft and 2 flights stairs	Calculated Work Output
Lift and carry 147lbs* pump up and down and 150 ft *2 people, therefore ~ 73.5 lbs (33kg)	Calculated Work Output for single person

kg = kilogram; m = meter; ft = feet; lb s= pounds

Table 6.6 Example Reported *r* values with Positive and Negative Correlations and Adjustments for Meta-Analyses

Military Task Category	Study Task Description	Test Group	Test	Test Description	Reported *r*	Performance Measurement Association	*r* used for Meta-analysis
Casualty Drag	80kg mannequin 30 m	AER	Run-Treadmill	Distance in 12 min	**-0.33**	Shorter time to drag mannequin associated with a longer distance in 12 minutes	**.33**
Casualty Drag	82 kg 25.5 m, level grass	AER	Run-Treadmill	Distance to fatigue	**-0.47**	Shorter time – Longer distance	**.47**
Casualty Drag	120 lb (54 kg)Dummy, 50 ft (15 m)	AER	Run	Timed 1 M (1.6K)	**0.35**	Shorter time associated with shorter time to run 1M	**.35**
Casualty Drag	120 lb (54 kg)Dummy, 50 ft (15 m)	AER	Run	Timed 1 M (1.6K)	**0.30**	Shorter time – Shorter time	**.30**
Casualty Drag	50m to 80kg (177 lb) dummy by web, drag 50m	AER	Run	Timed 2 M (3.2K)	**0.25**	Shorter time – shorter time	**.25**
Casualty Drag	79.5 kg mannequin 30.5 m	AER	Run	Timed 1.5M (2.4K)	**0.23**	Shorter time – Shorter time	**.23**
Casualty Drag	82 kg 25.5 m across level grass	AER	Run-Treadmill	Maximum VO_2 estimate	**-0.45**	Shorter time – Maximum VO_2	**.45**

kg = kilogram; m = meter; ft = feet; min= minutes; K = kilometer

Table 6.7 Identified Physical Fitness Tests and Groupings

Fitness Component and Body Region	Fitness Tests Identified in Systematic Review Dataset[1]	Extraction Code[2]
CARDIORESPIRATORY ENDURANCE (Aerobic Fitness)	1Mile timed run	AER_tr
	1.5M (2.4 K) timed run	AER_tr
	2M (3.2 K) timed run	AER_tr
	VO2 max from Shuttle - multistage 20m repeat maximum speed	AER_v
	VO2 max from Step test	AER_v
	VO2 max from treadmill test	AER_v
	Distance in 12 min or to fatigue on Treadmill Shuttle – maximum #20m sprint	AER_d
	repeats in 2 min	AER_d
MUSCLE ENDURANCE **Upper Body**	Arm Curl – Endurance Hold; max14-15kg repeats (ILM/weights)	UB_E
	Arm Dip – Endurance 1min	UB_E
	Arm Lift – Endurance Timed, 22.7kg, 60 Repeats ILM Arm	UB_E
	Arm Row 20.5 kg dumbbells max repeats	UB_E
	Bench Press Max # reps 45kg/80 lbs; to fatigue	UB_E
	Ergometer – #rev at 30seconds at 600kpm	UB_E
	Grip – Endurance 25kg force – hold duration Dyn	UB_E
	Pull Up max #/no time limit; 1 minute	UB_E
	Push Up max #/no time limit; 1 minute, 2 minute, UNK	UB_E
	Shoulder Press, 11 kg repeats	UB_E
	Weighted Hold, 1.2 kg bar weights	UB_E
Lower Body	Shuttle – anaerobic agility 5x30m (150y) w COD & zig zag	LB_E
	Sprint, short – 100 yd	LB_E
	Step test – 1 min 'anaerobic' power	LB_E
	Sprint, long – 400m	LB_E
	Sprint, long – 300m w 2 right turns	LB_E
	Leg Extension, 50 rep at 180d	LB_E
	Leg Press reps to fatigue	LB_E
	Squat – Endurance, 45kg lift .36m repeats	LB_E
	Squat – Endurance, max reps 61 kgs	LB_E
	Wall Sit, max time	LB_E
Core/Trunk	Sit ups (SU), 1-2 minutes	TR_E
	Ab Curl, max number reps, weights	TR_E
Whole Body	BodyProneHold	WB_E
MUSCLE STRENGTH **Upper Body**	Arm Lift, avg of 3 strain gauge pull (lift) from elbow; Max 1.52/1.83 m; 3 practice	UB_S
	Arm Press, Max weight 152cm	UB_S
	Arm Pull, Max weight 3; 1 RM max weight; 1 hand gauge max	UB_S
	Arm Curl, Max weight to Elbow, ILM	UB_S
	Arm Flex, Isometric	UB_S
	Arm Push, Max 3 (UBSD/weights)	UB_S
	Arm Row, 1RM	UB_S
	Bench Press, I- 5RM; max or best of 3	UB_S
	GRIP-Strength Dominant hand; combined; average; Sum 2; Sum 3; unknown	UB_S
	Upright Pull	UB_S
Lower Body	Jump-Counter Move Jump (CMJ)	LB_S
	Jump-Standing Broad Jump (SBJ), Max 3 or best distance	LB_S
	Jump-Squat, 1RM	LB_S
	Jump-Vertical Jump (VJ), Max 3 or power calculation	LB_S
	Leg Extension, Max 3 Cybex II Dyn	LB_S
	Leg Flex, Max 3 Cybex II Dyn	LB_S
	Leg Press, 1RM	LB_S
	Squat, 1-5 RM weights	LB_S
Core/Trunk	Ab-ISO 3-5 sec best of 3, ABMED	TR_S
	Back Extension, Max 2-3, Dyn	TR_S
	Trunk Extension, Electric Dyn	TR_S
	Trunk Flex, Electric Dyn	TR_S
Whole Body	Arm-Leg-Peak Extension, avg of R&L arm& leg, Cybex	WB_S
	Arm-Leg-Peak Extension, avg of R&L arm& leg, Cybex	WB_S
FLEXIBILITY	Sit & Reach	FLX
Whole Body-All	APFT	WB_All

[1] M = Mile, K = kilometer; kg = kilogram; no = number; m = meter; rev=revolutions: Dyn=dynamometer; ILM isometric lift machine, ISO isometric, avg = average; min = minutes, sec = seconds; RM – repetition maximum

[2] *Extraction code for groupings in meta-analyses spreadsheets: AER = Aerobic where d= for distance, tr= timed run, and V= VO_2 max (measured or estimated); UB= Upper Body; LB= Lower Body; CR = Core/Trunk (in spreadsheets =TR for Trunk); WB= Whole Body (all Limbs) WB- All = Whole Body All (total APFT score); "E" Endurance, "S" = strength. Example, UB-E = Upper Body-Endurance test.*

6.3 Meta-analyses Results

The results of the meta-analyses are presented in four different ways. **Table 6-8** presents the pooled correlations of types of physical component fitness test groups to military tasks, **Table 6-9** presents the pooled correlations of specific fitness tests to military tasks, Table **6-10** presents a summary of the ranked strengths of the pooled correlations for each fitness test group, and **Table 6-11** provides averages of the pooled correlations for each fitness test group.

6.3.1. *Pooled r Values for Correlations between Grouped Types of Fitness Tests and Military Tasks*

Table 6.8 is a condensed version the descriptive statistics resulting from the meta-analyses for each task category and fitness test group combination that is presented in **Appendix G**. From the studies selected for the analyses, most of the tasks had been evaluated against several or most fitness groups. The Loaded March task was least studied (i.e., had least available correlation data applicable for this review). The Casualty Drag, though well studied, had relatively weak overall pooled correlations to the different fitness groups. The Push/Pull task also yielded relatively weak correlation to different fitness groups. Correlation data between military tasks and flexibility tests were limited. Even less whole body (limb strength) fitness test correlations were identified. As a result, only a few pooled *r* values could be calculated for these fitness groups. Whole body 'All' correlations (i.e., the use of combined APFT event scores) were not adequately identified in studies to perform a meta-analysis for any task.

- <u>Cardiorespiratory tests</u>: The cardiorespiratory (aerobic) test group had pooled *r* values that ranged from 0.09 – 0.80 covering eleven of the 12 tasks. Very strong (>0.70) pooled *r* values were calculated for the Lift and Carry task and Crawl task; and strong pooled *r* values ($\geq$0.50<0.70) were calculated for the Repeated Lift and Lower, Stretcher Carry, Move fast, Climb, Dig, and Multi-activity tasks. A strong correlation (0.60) reported for the Loaded March reflected only a single study, so is not a pooled correlation. The correlations with Single Lift and Lower, Casualty Drag, tasks were fair $\geq$ 0.30 -0.40) while Push/Pull was weak (<0.30).

- <u>Muscular Endurance tests</u>: Upper body endurance tests (pooled *r* value range = 0.33 – 0.66) were well studied with different tasks; as a result pooled correlations were calculated for all task categories. Strong pooled *r* values were calculated for the Repeated Lift and Lower, Stretcher carry, and Crawl tasks. The Casualty Drag and Dig tasks had the weakest pooled *r* values for upper body endurance. Lower body muscular endurance tests were relatively well studied except with the Push/Pull, Crawl, and Dig tasks. Strong pooled *r* values were calculated for single and repeated Lift and Lower, Move fast, and Multi-activity tasks. The weakest pooled *r* values were for Push/Pull and Loaded March tasks. Core/Trunk endurance tests were well studied except for with the Loaded March. Though moderate pooled *r* values were calculated for the Climb and Crawl tasks, all of the nine other task groups had weak correlations to the Core muscular endurance tests.

- <u>Muscular Strength tests</u>: Correlations between muscular strength tests and military tasks were well studied. As a result pooled correlations were calculated for all task categories for both of these fitness test groups. For upper body strength tests (pooled r value range = 0.22 – 0.75), the pooled *r* value for Single Lift and Lower task was highest (very strong) Repeated Lift and Lower and Stretcher Carry tasks, and weakest for Loaded March, Casualty Drag, and Climb. For lower body strength tests (pooled *r* value range = 0.09 – .73), the pooled r value for the Stretcher Carry task was the most notable (very strong), though were also strong for Repeated and Single Lift and Lower, Move Fast, and Crawl and Dig tasks. The Climb, Push/Pull, Loaded March, and Casualty Drag had fair to weak correlations with muscular strength tests. Core Strength fitness tests pooled correlations were calculated for 8 tasks, resulting in a range of strong to weak *r* values. The strongest correlations were with Crawl and Repeated Lift and Lower tasks. Whole body limb strength tests were not frequently reported. The reported correlations yielded pooled *r* values for only 3 tasks (two moderate and one weak).

- Flexibility tests: Flexibility tests (consistently measured by the sit and reach test) were not frequently included in the identified studies. The reported correlations yielded pooled *r* values for only 3 task categories, all pooled *r* for the these tasks were weak.

6.3.2. *Pooled r Values for Correlation between Specific Fitness Tests and Military Tasks*

Table 6.9 presents the pooled correlations for the follow-on analyses of specific fitness tests. It is noted that the data sets became smaller for these specific test analyses (i.e., there were fewer correlation values to pool). The tests evaluated included push-ups, sit-ups, and cardiorespiratory (aerobic) tests, especially as they serve as the existing Army test (i.e., APFT). Other specific fitness tests with a robust data sets included the Grip Strength tests as test in the upper body Strength test group, and Jump tests as lower body Strength tests (to include Vertical and Standing Broad Jump), and sprint tests (varying distances) as tests of lower body muscular endurance. Though it further reduced the number of original correlations to be pooled, the cardiorespiratory aerobic tests were of more varied types, so these were broken into 3 separate pooled *r* values: Timed distance runs (which includes 1, 1.5, and 2 mile distances), distance run tests which includes track or treadmill tests for maximum distances in a set time (e.g., maximum distance in 12 minutes), and tests that provided VO_2 measurements.

- Specific cardiorespiratory tests: Cardiorespiratory (aerobic) tests that provided VO_2 max measurements yielded the strongest pooled r values. These were even stronger than the overall pooled r values for all the aerobic tests combined. These tests all very strongly correlated with Lift and Carry, Repeated Lift and Lower, and stretcher Carry tasks (all pooled r > .0.70). While the strength of the correlations are less strong for tests that provide surrogate measurements (i.e., the timed runs and distance runs), strong correlations are also noted for several tasks including Repeated Lift and Lower, Stretcher carry, as well as Move Fast and Multi-Activity.

- Specific muscular endurance tests: Push-ups were well studied across all task categories (pooled *r* range 0.23 - 0.58), pooled r values slightly lower than that for the comparable values for the full set of Upper Body endurance tests *(r* range 0.33 - 0.66). Though data was only available to calculate pooled *r* values for 4 tasks Sprints tests, as a test of lower body muscular endurance (with elements of speed and power), yielded a very strong pooled *r* with the Multi-Activity task, and strong pooled *r* values for Single Lift and Lower, Lift and Carry, and Casualty Drag tasks. These pooled *r* values for the Multi-activity, and the Casualty Drag are the highest pooled *r* values for these two tasks for any general fitness group or specific fitness test. Since the Core endurance tests were almost all sit-ups, the resulting pooled *r* values for the sit ups are essentially equal to those of overall Core endurance. Though the data suggest weak correlation with core endurance to military tasks, is not clear whether the sit up test is an adequate measurement of this physical component.

- Specific muscular strength tests: Of upper body strength tests (overall pooled *r* range 0.22- 0.75), grip tests, which were studied for all tasks, had a comparable pooled *r* range of 0.21 – 067). For lower body strength, pooled *r* values were calculated for three tasks with standing broad jump (SBJ) and seven tasks with Vertical jump tests. These tests (as measures of explosive power, a surrogate for strength), yielded very strong or strong pooled *r* values for Single Lift and Lower and Move Fast tasks. The SBJ also has a very strong pooled *r* for Stretcher carry, while a single study correlation for the Vertical Jump test suggests it too may be very strongly correlated to this task.

6.3.3. *Descriptive Summary of Strengths of Pooled Correlation Values by Fitness Test Groups*.

Table 6-10 provides a descriptive summary of the number and strengths of overall task-test pooled correlations calculated for each fitness test group. Cardiorespiratory (aerobic) tests yield the greatest number of very strong (two) and strong (six) correlations with tasks. Lower body strength had the next greatest number (one very strong and five strong).

6.3.4. *Average Pooled Correlation Values by Fitness Test Groups.*

Table 6.11 presents a descriptive summary of the weighted averages of correlation coefficients for all tasks within each physical fitness test group. Averages were based on correlation coefficients calculated using all studies. Average (all tasks) indicates the average correlation from all tasks for a given test. All correlation values were used and were weighted based on the number of studies included in each task-test correlation. As previously indicated, the Table again shows that cardiorespiratory (aerobic) fitness tests are most strongly correlated with military tasks (average r for all tasks = 0.53, average r for top 5 tasks = 0.68). Both upper and lower body muscular endurance and strength tests have strong average and top 5 pooled correlations, while core endurance (e.g., sit-ups) and flexibility tests are weakly correlated.

Table 6.8 Pooled *r* Values for Correlations between Types of Fitness Tests and Military Tasks

Task Category	Physical Fitness Component Test Groups									
	Cardio Respiratory (Aerobic)	Muscular Endurance			Muscular Strength				Flexibility	Overall
		Upper Body	Lower Body	Core/ Trunk	Upper Body	Lower Body	Core/ Trunk	Whole Body	FLX	All-WB
Lift & Lower (Single)	**0.30**	**0.42**	**0.56**	**0.16**	**0.75**	**0.60**	{0.57}	-	**0.16**	-
Lift & Lower (Repeated)	**0.60**	**0.62**	**0.55**	**0.29**	**0.61**	**0.57**	**0.56**	-	-	-
Lift & Carry	**0.72**	**0.50**	**0.47**	**0.25 ŧ** (0.37)	**0.43** (0.46)	**0.41**	**0.41**	-	{0.01}	-
Casualty Drag	**0.32**	**0.33** (0.36)	**0.46** (0.52)	**0.16** (0.19)	**0.38**	**0.27**	**0.27**	**0.24 ŧ**	{0.06}	-
Stretcher Carry	**0.66**	**0.58** (0.61)	-	**0.31** (0.48)	**0.65**	**0.73**	{0.67}	-	-	-
Push/Pull	**0.09**	**0.46**	**0.35**	**0.20**	**0.46**	**0.21**	**0.42**	-	{0.06}	-
Loaded March	{0.60}	**0.48**	**0.38**	-	**0.28** (0.36)	**0.32**	**0.01 ŧ** (0.04)	-	-	{0.43}
Move fast	**0.59**	**0.47**	**0.69**	**0.39**	**0.35**	**0.58**	-	-	**0.08 ŧ**	{0.59}
Climb	**0.55**	**0.46**	**0.44**	**0.43**	**0.22 ŧ** (0.30)	**-0.09 ŧ** (0.04)	**0.38**	**0.46**	{0.25}	-
Crawl	**0.80**	**0.66**	-	**0.48**	**0.49**	**0.65**	**0.64**	-	-	{0.67}
Dig	**0.62**	**0.38**	{0.15}	**0.21 ŧ**	**0.44**	**0.53**	**0.47**	-	-	-
Multi-Activity	**0.52**	**0.46**	**0.64**	**0.38**	**0.42**	**0.47**	{0.53}	**0.49**	**0.08 ŧ** (0.09)	{0.57}

Appendix G presents all *r* values in conjunction with associated number of studies (N), Confidence Intervals (CI), and minimum-maximum *r*- value ranges. Except for the values noted with a " ŧ " the CIs did not include "0," indicating $p < 0.05$; whereas CIs for values noted with a " ŧ " did include "0", thus $p > 0.05$.

Bold numbers reflect correlation from meta-analyses of data from more than 1 study

{ } reflect correlation *r* values from a single study (only data found for task-test type); this resulting *r* is not a pooled value from a meta-analysis

( ) reflects overall correlation *r* value that has been adjusted by removing an outlier data value (e.g., sign of the correlation *r* was inconsistent with other *r*'s)

Correlation scale ‡: $0.70 \le r < 1.0$ very strong
$0.50 \le r < 0.7$ strong
$0.40 \le r < 0.5$ moderate
$0.30 \le r < 0.4$ fair
$r < 0.3$ weak

‡ Per paragraph 5.2e this scale is based on review of other published criteria regarding the interpretation of a correlation coefficient as it applies to type of evaluated test data.

Table 6.9 Pooled *r* Values for Correlations between Specific Fitness Tests and Military Tasks

	Physical Fitness Component Test Types and Specific Tests														
	Cardio Respiratory (Aerobic)				Muscular Endurance						Muscular Strength				
					Upper Body		Lower Body		Core/Trunk		Upper Body		Lower Body		
	ALL	Timed runs (1, 1.5, 2 M)	Max distance (e.g.,12 min)	Est. VO_2 max shuttle/ step	ALL	Push Up	ALL	Sprint	ALL	Sit Up	ALL	Grip (Strength)	ALL	Jump-SBJ	Jump-Vertical
Lift & Lower (Single)	**0.30**	**0.30**	**-**	**-**	**0.42**	**0.43**	**0.56**	**0.63**	**0.16**	**0.16**	**0.75**	**0.67**	**0.60**	**0.71**	**0.52**
Lift & Lower (Repeated)	**0.60**	**0.51**	**-**	**0.70**	**0.62**	**0.57**	{0.55}	-	**0.29**	**0.29**	**0.61**	**0.59**	**0.57**	**-**	{0.79}
Lift & Carry	**0.72**	{0.67}	{0.12}	**0.84**	**0.50**	**0.47**	**0.47**	**0.55**	**0.25**	**0.26**	**0.43**	**0.36**	**0.41**	{0.45}	**0.43**
Casualty Drag	**0.32**	**0.30**	**0.40**	{0.45}	**0.33**	**0.16**	**0.46**	**0.53**	**0.16**	**0.16**	**0.38**	**0.41**	**0.27**	{0.25}	**0.31**
Stretcher Carry	**0.66**	{0.36}	**0.58**	**0.71**	**0.58**	**0.47**	-	-	**0.31**	**0.31**	**0.65**	**0.61**	**0.73**	**0.83**	{0.71}
Push/Pull	**0.09 ŧ**	{0.10}	{0.05}	**-**	**0.46**	**0.23**	**0.35**	{0.67}	**0.20**	**0.20**	**0.46**	**0.47**	**0.21**	**-**	**0.23**
Loaded March	{0.60}	{0.60}	**-**	**-**	**0.48**	**0.34**	**0.38**	-	**-**	**-**	**0.28**	**0.21**	**0.32**	{0.45}	**-**
Move fast	**0.59**	**0.58**	**-**	{0.69}	**0.47**	**0.52**	**0.69**	{0.69}	**0.39**	**0.39**	**0.35**	**0.23**	**0.58**	**0.52**	**0.60**
Climb	**0.55**	**{0.56}**	**0.48**	{0.63}	**0.46**	**0.44**	**0.44**	{0.63}	**0.43**	**0.45**	**0.22**	**0.23**	**-0.09**	**-**	{-0.24}
Crawl	**0.80**	**-**	**-**	**0.80**	**0.66**	**0.58**	-	-	**0.48**	**0.48**	**0.49**	**0.34**	**0.65**	**-**	{0.75}
Dig	**0.62**	**-**	**-**	**0.62**	**0.38**	**0.29**	{0.15}	-	**0.21**	**0.21**	**0.44**	**0.38**	**0.53**	**-**	**0.47**
Multi Activity	**0.52**	**0.52**	**0.51**	{0.63}	**0.46**	**0.42**	**0.64**	**0.71**	**0.38**	**0.38**	**0.42**	**0.42**	**0.47**	{0.69}	**0.52**

Appendix G presents all *r* values in conjunction with associated Confidence Intervals (CI) and minimum-maximum value ranges. Except for the values noted with a " ŧ " the CIs did not include "0," indicating $p < 0.05$; whereas CIs for values noted with a " ŧ " did include "0", thus $p > 0.05$.

Bold numbers reflect correlation from meta-analyses of data from more than 1 study

{ } reflect correlation *r* values from a single study (only data found for task-test type); this resulting *r* is not a pooled value from a meta-analysis

( ) reflects overall correlation *r* value that has been adjusted by removing an outlier data value (e.g., sign of the correlation *r* was inconsistent with other *r*'s)

Correlation scale ‡:

$0.70 \le r < 1.0$	very strong	(darkest green)
$0.50 \le r < 0.7$	strong	(medium green)
$0.40 \le r < 0.5$	moderate	(light green)
$0.30 \le r < 0.4$	fair	(white)
$r < 0.3$	weak	(white)

‡ Per paragraph 5.2e

Table 6.10 Summary of Strengths of Pooled Correlation Values by Fitness Test Groups

Strength of Pooled Correlations	Number of Task Categories Associated Pooled Correlation of Different Strengths [a]									
	Cardio Respiratory	Muscular Endurance			Muscular Strength				Flexibility	Overall
		Upper Body	Lower Body	Core/ Trunk	Upper Body	Lower Body	Core/ Trunk	Whole Body	FLX	All-WB
Very Strong ≥ 0.70	**2**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**
Strong 0.50 ≤ r < 0.7	**6**	**4**	**3**	**0**	**2**	**5**	**2**	**0**	**0**	**0**
Moderate 0.40 ≤ r < 0.5	0	6	3	2	5	2	3	2	0	0
Fair 0.30 ≤ r < 0.4	2	2	2	2	2	1	1	1	0	0
Weak r < 0.3	1	0	0	7	2	3	2	0	3	0
Single study - inadequate to pool for task(s)	1	0	1	0	0	0	3	0	4	4
No studies/data found for task(s)	--	--	3	1	--	--	1	9	5	9

[a] Total of 12 task categories evaluated, strength categories only represent pooled correlations (not correlations from single studies)

Table 6.11 Average Pooled Correlation Values by Fitness Test Groups

Physical Fitness Test Groups	Average (all tasks)	Average [a] (weighted)	Average [b] (top 5 tasks)	Average [c] (excluding low 3 tasks)	Total # of tasks that test was compared [d]	Average # of *correlations with test group* per task [d]
Cardio Respiratory	**0.53**	**0.53**	**0.68**	**0.63**	12	4.7
Upper Body Strength	0.46	0.49	**0.59**	**0.51**	12	10.2
Lower Body Strength	0.44	0.45	**0.63**	**0.54**	12	7.0
Upper Body Endurance	0.49	0.48	**0.57**	**0.52**	12	9.8
Lower Body Endurance	0.47	0.48	**0.58**	**0.54**	10	5.1
Core/Trunk Strength	0.45	0.43	**0.59**	**0.53**	11	2.3
Core/Trunk Endurance *(sit ups)*	0.30	0.30	0.40	0.34	11	5.7
Flexibility	0.10	0.10	0.13	0.14	7	2.1
Whole Body -Strength	0.40	0.40	0.40	Only 3 tasks	3	2.0
Whole Body - All *(APFT total score)*	(0.57) [e]	(0.57) [e]	(0.57) [e]	Only 4 tasks	4	1.0

Correlation scale (discussed in Section 5.2 e) : where 0.70 ≤ r < 1.0 very strong, 0.50 ≤ r < 0.7 strong, 0.40 ≤ r < 0.5 is moderate, and r < 0.4 weak. No averages correlations for overall multiple tasks were "very strong"; those that were "strong" are shaded and bolded

Data robustness rankings

#tasks compared with test group x average # r values per studied tasks ≥ 60 = Robust

#tasks compared with test group x average # r values per studied tasks ≥ 25 < 60 = Modest

#tasks compared with test group x average # r values per studied tasks < 25 = Limited

[a] Average (weighted) indicates the average correlation from all tasks for a given test, but weighted based on the number of studies used to calculate each task's meta-analysis correlation.

[b] Average (top 5) was calculated by taking the average of only the five strongest (closer to 1.00) correlation coefficients for a given test. For tests that only had correlations for five tasks or less, the average was calculated using all tasks.

[c] Average (excluding low 3 tasks) was calculated by taking the average of all tasks correlations for a given test except for the three weakest (closest to 0.00) correlation coefficients.

[d] The final two columns in Table 6.8 (number of tasks that test covers and average number of studies per task) indicate which tests were more 'popular' among the studies compiled and analyzed.

[e] Only a single study was identified.

7 Discussion

7.1 Data sets and groupings

All the individual studies identified during this review provided correlation coefficients between specific fitness tests and specific military-relevant tasks. The uniqueness and power of our analyses was not only the grouping of data from different (but similar) populations and tasks, but also the grouping of physical fitness tests by the health-based components of physical fitness and body regions. Grouping data from studies of relatively similar populations, tasks, and types of physical fitness tests provided an organized, justified framework for interpreting multi-study data. The size of the overall data set, as well as the breadth of the variables represented, allow a better assessment of existing comparable data than any individual study. The results of these analyses provide scientific and legal defensible support to the selection of a series of physical fitness tests considered surrogates for the assessment of a Soldiers baseline physical capacity to perform key military tasks.

7.2 Assessment of Specific Physical Fitness Groups and Tests

7.2.1. *Cardiorespiratory (Aerobic) Tests.*

The results of these analyses demonstrate that cardiorespiratory (aerobic) fitness is the health-related fitness component of greatest importance to the performance of key common military tasks. As the dataset of correlation coefficients for cardiorespiratory tests to the different tasks was considered relatively robust, this finding is not considered spurious. While this finding supports those of some past individual studies [28, 67, 115], it is contrary to recent subject matter expert opinion [65] that identified aerobic fitness (i.e. cardiorespiratory endurance) as one of the least important of eleven health- and skill- related physical fitness components (see **Figure D-1**). In fact, aerobic fitness was ranked as the least important of the four health-based components evaluated in our review).

Of the cardiorespiratory tests evaluated separately (i.e., timed runs, runs for maximum distance in set time, and tests provided VO_2 max measurements), the VO_2 max measures provided the strongest correlation to tasks. This is not surprising since the "gold standard" for determining the *validity* of a cardiorespiratory tests is based on its measure (e.g. run time) compared to VO_2 max. VO_2 max reflects the rate at which energy can be supplied to fuel longer-term physical activity [67, 116]. The high rate at which military personnel must utilize energy especially in combat environments has been demonstrated through specific measurements of energy expenditure [117, 118] (Hoyt 2006). Physical overexertion in conjunction with an energy deficit was also proposed as the underlying cause of performance decrement of Soldiers after 72 hours of operational stress [119]. Therefore, for continued operations that involve multiple and repeated tasks over time, cardiorespiratory endurance appears to be predominant fitness component. This current review and meta-analyses supports this assertion.

Though cardiorespiratory endurance tests that provide measures of VO_2 max yield the strongest correlations to military task performance, these tests tend to be more logistically involved and thus less 'field expedient' than run tests. A previous review found reasonably good validity of distance run tests as field expedient surrogates of VO_2 max measurements. A summary of the calculated validity of various run distances against VO_2 max are presented in **Table 7-1**. A similar finding was also described by one of the identified studies from this review [28]. Of the distances evaluated in our present analysis (1, 1.5 and 2 mile), the data was too limited to calculate separate pooled correlations to determine the distance with the strongest correlation to tasks. However, data shown in **Table 7-1** demonstrates that timed runs equal to or greater than 1.5 miles appear to be the most valid surrogates for VO_2 max measurements [67]. While the data supports the validity of using a timed-run test of 1.5 to 2 miles to measure cardiorespiratory endurance, data do not support discernible differences in the validity of 1.5 over 2 mile distances. The reliability of these timed-run

tests (meaning that they can be conducted in a manner that provides consistent results), has also been reported as very good. **Table D-1** describes reported reliability coefficients for run tests of 0.3 up to 2 miles to be >0.82 - 0.98 [67].

Table 7-1. Studies Examining Relationships between VO_2 Max and Running Tests of Various Distances [a]

Ref	Test Distance (miles)	STUDY POPULATIONS	Age years	Weight kg	VO_2 Max ml/kg/min	Validity correlation VO_2 Max & run time or speed	AVG Validity [d]
224	**0.1**	11 college students, moderately trained	20±1	72±9	57±4	-0.05	**-0.22**
32	**0.1**	44 college men	22±3	78±11	53±6	-0.52	
231	**0.1**	30 untrained college men	23±3	76±13	54±6	-0.08	
266	**0.25**	30 untrained college men	21±2	74±12	53±6	-0.22	**-0.44**
224	**0.3**	11 college students, moderately trained	20±1	72±9	57±4	-0.31	
32	**0.3**	44 college men	22±3	78±11	53±6	-0.78	
231	**0.3**	30 untrained college men	23±3	76±13	54±6	-0.29	
224	**0.5**	11 college students, moderately trained	20±1	72±9	57±4	-0.67	
231	**0.5**	30 untrained college men	23±3	76±13	54±6	-0.35	
224	**1**	11 college students, moderately trained	20±1	72±9	57±4	-0.79	**-0.62**
266	**1**	30 untrained college men	21±2	74±12	53±6	-0.29	
32	**1**	44 college men	22±3	78±11	53±6	-0.74	
231	**1**	30 untrained college men	23±3	76±13	54±6	-0.43	
101	**1.2**	9 men in the British Royal Air Force	31±2	70±4	64±3	-0.83	
80	**1.5**	21 female college joggers	20±2	57±8	46±6	-0.92	**-0.82**
271	**1.5**	106 California Highway Patrolmen [b]	-31[b]	-83[b]	39.9[b]	-0.68	
277	**1.5**	38 women (W)	33±3	64±8	41±7	-0.79W	
191	**1.5**	32 male college physical education majors	20±0	74±3	60±6	-0.87[c]	
224	**2**	24 moderately well trained men	40±6	80±11	49±6	-0.86	**-0.80**
192	**2**	44 men (M), active duty Army	31±7M	78±9M	50±8M	-0.91M	
192	**2**	17 women (W), active duty Army	28±4W	61±8W	42±6W	-0.90W	
168	**2**	70 male US Army War College students	43±2	80±8	43±5	-0.78	
224	**2**	11 college students, moderately trained	20±1	72±9	57±4	-0.85	
266	**2**	30 untrained college men	21±2	74±12	53±6	-0.47	
231	**2**	30 untrained college men	23±3	76±13	54±6	-0.76	
64	**2**	18 experienced male distance runners	28±9	70±8	62±8	0.83[d]	
215	**3**	14 male Marines	*Not reported in study*			-0.65	**-0.70**
266	**3**	30 untrained college men	21±2	74±12	53±6	-0.43	
231	**3**	30 untrained college men	23±3	76±13	54±6	-0.82	
213	**3.1**	36 men	19-36	71±8M	59±7M	-0.76M	
213	**3.1**	38 women	19-36	57±9W	47±6W	-0.83W	
64	**6**	18 experienced male distance runners	28±9	70±8	62±8	0.86[d]	**-0.90**
203	**6.2**	9 endurance trained Men	35±6	74±6	59±10	-0.95	
64	**9.3**	18 experienced male distance runners	28±9	70±8	62±8	0.89[d]	
64	**12**	18 experienced male distance runners	28±9	70±8	62±8	0.91[d]	**-0.76**
173	**18.6**	11 marathoners	32±6	68±5	66±2	-0.71	
94	**26.2**	50 marathoners	36±8	70±6	65±6	-0.63	
183	**26.2**	18 male (M) marathoners	34±7M	68±9M	61±10M	-0.88M	
183	**26.2**	10 female (W) marathoners	30±7W	59±8W	52±6W	-0.63W	
237	**26.2**	35 marathon runners	30	67	66	-0.78	
64	**26.2**	13 experienced male distance runners	28±9	70±8	62±8	0.91[d]	

[a] Adapted from Table 6 in Knapik, 2004 [67].
[b] Values are approximate as not all subject completed both tests
[c] Correlation is not with run time but rather VO_2 max with an estimated VO_2 max from simple linear regression
[d] Correlation is between VO_2 max running speed rather than run time – if calculated as total run time the correlations would have been negative; therefore Average Validity values were calculated using same direction (negative) correlations
[e] Age, weight, and VO_2 max values were calculated as the weighted average 3 groups in the article

7.2.2. *Muscular Endurance Tests.*

The results of our analyses indicate that while both upper and lower body muscular endurance are important physical fitness components for military physical task performance, core endurance is of less importance. The overall relevance of the muscle endurance component for performance to the various tasks evaluated appears slightly less than that of muscular strength. This finding is consistent with recent subject matter expert opinion (**Figure D-1**) [65]. As the dataset of correlation coefficients for these physical fitness groups to the different tasks was considered relatively robust, this finding is not considered spurious. The specific fitness tests evaluated are discussed below. The validity of muscular endurance tests cannot be measured since there is no physiological or biological gold standard measurement for comparison. As such the reliability and expediency of the tests are the focus of the following descriptions:

- <u>Push-up test</u>. Our results support the appropriateness of using the current push-up test as a measure of upper body muscular endurance. Recent subject matter experts also identified the push up test as a field expedient test of choice for both muscle endurance as well as muscle strength (**Figure D-2**) [65]. The reliability of using the push-up test has previously been reported as good (per **Table D-1**, reported reliability coefficients ranged from 0.76 – 0.83) [67]. It is a field expedient test that requires no equipment and limited instruction.

- <u>Lower body endurance tests</u>. The pooled correlations for “sprint tests” (e.g. 100 to 400 meters) to several military tasks indicate that these tests, which address elements of speed and power, provide reasonable measures of lower body muscular endurance. A previous review of sprint tests and shuttle tests indicates these tests have good reliability (per **Table D-1**, reliability coefficients ranged from 0.87- 0.98) [67, 120]. They require minimal equipment and logistics to conduct. Other tests of overall of low body endurance included shuttle tests, dynamic squats, incremental lift machine repeats that are expected to be associated with more logistical requirements than a sprint test.

- <u>Sit up test</u>. Our results do not indicate a notable correlation between sit-up test and Soldier’s performance of physical tasks. The limited value of the sit-up as a test of military fitness has been previously indicated [28, 67]. It was not identified as a recommended field test by the NSCA [65]. The reliability of the test has also been reported as quite variable (per **Table D-1**, reliability coefficients ranged from 0.57-0.72) [67].

7.2.3. *Muscular Strength Tests.*

The results of these analyses indicate that after cardiorespiratory fitness, muscle strength is the next most relevant physical fitness component for performance of individual military physical tasks. This finding is more supportive of recent subject matter expert opinion (**Figure D-2**) [65] which identified muscular strength as the predominant physical component for military performance. As the dataset of correlation coefficients for these physical fitness groups to the different tasks was considered relatively robust, these findings are not considered spurious. The specific fitness tests evaluated are discussed below. The validity of muscular strength tests cannot be measured since there is no physiological or biological gold standard measurement for comparison. As such the reliability and expediency of the tests are the focus of the following descriptions:

- <u>Grip tests</u>. The strengths of task correlations for grip tests were slightly lower than comparable pooled r values for the overall upper body strength tests. While the grip test requires the use of equipment (hand dynamometer), it is less complex equipment than many of the other upper body strength test identified (e.g., lift machines). However, the reliability of grip test would require consideration of various factors (i.e., the use of one or both hands and number of attempts, use of pre-post maximal exertion) [121].

- Jump tests. The literature provides documentation of various types of jump tests (squat, vertical jump (VJ), standing broad jump (SBJ), counter jump, and triple or single hops) that have been suggested as a means to measure lower body power. Jump tests have been described as having good reliability (per **Table D-1**, reported reliability coefficients ranged from 0.76 - 0.96) [67, 122]. Data applicable for our review allowed us to evaluate the VJ and SBJ, both are shown to be strongly correlated to select military tasks. Jump tests like the SBJ or VJ were also recently identified as viable field expedient tests of power (an element of strength) **Figure D-2**) [65].

7.2.4. *Flexibility*.

The weak correlations identified in our analyses do not suggest flexibility is a key physical fitness component for the performance of military tasks. However, the data were limited - only some tasks were evaluated, and the bend and reach was the only test used.

7.2.5. *Whole Body- All*.

The data were too limited for the "Whole Body All" test group (e.g., combined APFT score) to analyze. However, it is reasonable to assume that the use of a combined score on tests that represent physical components most strongly correlated to the most tasks will increase the correlation of a combined score to the various tasks.

7.3 Gender Comparisons of Pooled Correlations

The majority of studies included in our review provided data for males. In addition, some study populations combined male and female data that could not be separated. However, some studies were only female populations, while some identified a subset of females studied. Therefore, as previously shown in **Table 6-4**, some separate male and female data were available for a limited comparative evaluation. Though our assessment is based on a small number of studies, pooled correlation were calculated for Stretcher Carry and the Crawl tasks with the five most studied fitness groups for these two tasks (**Table 7.2**). The results suggest similar trends for upper body endurance, and upper body and lower body strength core endurance. Of the two tasks evaluated, cardiorespiratory endurance (aerobic fitness) is the most highly associated physical fitness component to task performance for both genders.

Table 7.2 Gender Comparisons of Pooled Correlations

Task	Gender	Statistic	Cardio respiratory	Upper Body Endurance	Lower Body Strength	Upper Body Strength	Core Endurance (sit-ups)
Stretcher Carry	Male	r	**0.63**	**0.47**	**0.26**	**0.25**	**0.39**
		N	2	5	2	7	3
		CI	(.30, .83)	(.42, .52)	(-.10, .55)	(.14, .36)	(.12, .61)
		Range	.48 - .75	.15 - .51	.08 - .42	.07 - .65	.25 - .55
	Female	r	**0.60**	**0.33**	**0.36**	**0.34**	**0.42**
		N	2	5	2	7	3
		CI	(.39, .75)	(.25, .41)	(.27, .44)	(.19, .48)	(.32, .52)
		Range	.50 - .68	.21 - .73	.32 - .39	.16 - .71	.02 - .47
Crawl	Male	r	**0.63**	**0.62**	**0.3**	**0.15**	**0.41**
		N	2	3	2	4	2
		CI	(.59, .67)	(.57, .65)	(-.20, .68)	(.05, .25)	(-.04, .72)
		Range	.57 - .69	.42 - .64	.05 - .52	.08 - .27	.18 - .58
	Female	r	**0.74**	**0.54**	**0.4**	**0.14**	**0.59**
		N	2	4	2	4	4
		CI	(.60, .83)	(.47, .60)	(.00, .69)	(.06, .21)	(.51, .67)
		Range	.67 - .79	.39 - .60	.20 - .56	.12 - .16	.48 - .61

7.4 Threshold standards for minimum required performance

The strength of the correlations from this evaluation can be used to identify potentially useful fitness test measurements that can represent basic physical performance capacity. They do not, however, define necessary threshold criteria (e.g., minimum test standards) for physical performance success. For example, the tasks measurements in this evaluation reflected time, or weights, or number of repetitions. While less time, more weights, and more repetitions indicate better performance, the amount or time, weight, or repetitions necessary to achieve success ideally should reflect military operational performance objectives. A performance-based objective is critical to ensuring a test is gender-neutral.

Comparisons of existing male and female US Army physical fitness data from both current APFT tests as well as other recently proposed tests (e.g. shuttle run, sprint, rower) show, not surprisingly, that for most tests of physical fitness tests, males will tend to score higher (**Appendices J and K**). Therefore, a single cut off standard for any physical test will likely disproportionately favor males. However, DoD has been directed not to set quotas or adjust standards to ensure females can meet occupational performance objectives (**Section 4.2**; [5]). Therefore, regardless of the percentage of males versus females with passing scores, a single performance based objective standard would meet the gender-neutral performance based objective.

While the specific results of the meta-analyses do not provide minimum performance objectives to use as test standards, the following section provides a discussion of other requirements and evaluations relevant to this issue.

7.5 Other relevant requirements and considerations

7.5.1. *Army medical fitness for duty and job placement procedures.*

The USAPHC and others have previously recommended a tiered approach to physical testing that includes an assessment of a base level of fitness and then additional assessments according to specialty and common military tasks [24, 123]. While the pooled correlations from this analysis provide an indication of the strength of the relationship between physical fitness tests and basic Army job performance requirements, this is just one element of such a tiered approach. As with the current APFT, a test of basic military physical capacity would be <u>in addition to</u> the existing medical fitness standards [124] and military job (MOS)-specific physical demands requirements and PUHLES criteria [57] described in **Appendix C**. As presented in **Appendix C**, current MOS-specific physical demands and PUHLES indices provide a mechanism to screen individuals' capabilities to perform specific physical job tasks. Review of the example MOS task descriptions in **Appendix C** suggests that a more consistent, standardized, and transparent and quantified approach to assessing MOS-specific physical requirements and tasks is warranted. At this time, individual MOS-specific job analyses are in the process of being reassessed [125].

7.5.2. *Military gender-neutral standards.*

This study provides criterion validation of the 2-mile timed run and the push-up as tests of military physical occupational performance requirements. However, as previously noted in this report the existing test standards for these events are not performance-based. Instead they are based on arbitrarily established age and gender adjusted cut-points [15]. While the current analysis does not provide criteria for standards, the value of using a validated physical performance test is negated by gender or age adjustments.

- <u>Gender-neutral standards</u>. It is acknowledged that the differences in physiology of men and women will inhibit the ability of females to conduct certain physical tests at the same performance level as men [18, 21, 126-128]. As an example, **Appendices J and K** provide previously unpublished analyses conducted by the USAPHC-IPP. The analyses show the higher percentage of females than to males would fail the current APFT 2 mile run and push up test, as well as other tests such as a long jump and pull ups assuming a single 10% cut point. (The 10% cut point was a rounded value based on the existing 8% cut point discussed in Section 4.2.2.) The gender differences were not seen with the sit ups and also less substantial for a rower test, shuttle run, and half mile run. While some gender differences can be addressed by factoring in differences in height, weight, body mass index, and or age, accommodating any of these factors would negate the value of a job performance-validated test. Instead, a single common set of standards is needed for a test or series of reliable tests that have been validated against military job performance.

  <u>Canada's gender-neutral military test</u>. As an example of a single standard (gender neutral) military physical capacity test, the Canadian Armed Forces (CAF) recently established a new fitness test. This test **(Figure 7-1)** includes single minimum standards, which all Canadian Forces members must meet regardless of age and gender [77, 129]. The new CAF test includes simplified tasks intended to simulate the key performance tasks conducted by all Canadian Force members. While documentation of the validation process was not obtained for review during this study, a primary limitation of these types of tests is the increase in time and or cost associated with more complex resources and logistical procedures necessary to ensure standard test conditions and equipment. Such tests therefore may not be feasible as field expedient basic physical requirements tests for the U.S. Army. However, the Canadian test represents elements of the tasks highlighted by the current study. These tasks were shown to have strong correlations to various

(field-expedient) cardiorespiratory endurance and muscular strength and endurance (to include power and speed) tests. Just as ‘single minimum standards’ have been established for the Canadian tests to ensure age and gender neutrality, a parallel set of single minimum standards can be established for field expedient tests.

Figure 7-1. CAF Gender-Neutral Test

Test Component	Description	Standard
Sandbag Lift	30 consecutive lifts of a 20 kg sandbag to a height above 91.5 cm, alternating between left and right sandbags separated by 1.25 m.	3 minutes 30 seconds
Intermittent Loaded Shuttles	Using the 20 m lines, complete ten shuttles (1 shuttle = 20 m there, 20 m back), alternating between a loaded shuttle with a 20 kg sandbag and an unloaded shuttle, for a total of 400 m.	5 minutes 21 seconds
20 metre Rushes	Starting from prone, complete two shuttle sprints (1 shuttle = 20 m there, 20 m back) dropping to a prone position every 10m, for a total of 80 m.	51 seconds
Sandbag Drag	Carry one 20 kg sandbag and pull a minimum of four on the floor over 20 m without stopping. Number of sandbags being dragged depends on the type of floor.	Completed without stopping

7.5.3. *Relationship to injury.*

While a study of the association between physical injuries and physical fitness is outside of the scope of this analysis, a significant relationship has previously been established [67, 83, 127, 130]. Two key facets of the relationship are of relevance to the selection of Army physical fitness testing:

- <u>Low physical fitness indicates higher risk of injury</u>. Data from numerous studies indicate that individuals who have low levels of physical fitness are more likely to become injured during occupational job activities. Specifically, military assessments have shown that low cardiorespiratory endurance (aerobic fitness), low muscular endurance, as well as both high and low levels of flexibility, are strongly associated with higher injury incidence. Strong relationships have also been shown between low aerobic fitness or low muscular endurance and higher military attrition [67]. While not all studies show such findings, the data is relatively consistent. Even recent data shown in **Appendices J and K** shows that Soldiers who perform in the lowest Quartile (slowest runners or those who perform the least number of repetitions) have higher injury rates than those on middle and upper quartiles.

- <u>Strongest association is between injury and the cardiorespiratory fitness component</u>. Though significant relationships exist with muscular endurance and extremely high or low levels of flexibility, the cardiorespiratory fitness component is the most significant indicator for injury risk. This relationship may be because it is the component that is the most stressed or of the greatest exposure to those in the military occupation. This further supports the finding of this study’s analyses that the cardiorespiratory physical fitness component is overall the most critical to soldiers’ physical performance.

In summary, fitness has been associated with military injury and attrition, which are notable factors in military success. Physical test measurements provide a valuable metric for monitoring levels of physical fitness. The continued use of the 2 mile run time as a measure for cardiorespiratory endurance appears reasonable, especially since it represents the key physical component for

performance as well as for injury prediction. The continued use of push up test scores as a measure of muscular endurance for injury surveillance is also reasonable.

7.6 Limitations

7.6.1. *Use of the systematic review process*.

The SR process is a recognized, thorough, and transparent approach for determining the scientific weight-of-evidence. Using the SR methodology for this analysis resulted in the evaluation of data that thus far had only been interpreted in terms of the individual studies, each with their own flaws and limitations. The similarities in the combined data sets is considered much more substantial than any differences amongst them since the differences reflect inherent and expected variability. The resulting pooled r values are more robust estimates of correlation between the described tasks and various fitness tests than are provided by any individual study. Though SR methodology was followed, study investigators were limited to certain time and resource constraints that required modification to some of the SR steps (e.g., English language study data only, readily accessible studies, and a two-tiered (sequential) screening). Through this process we discovered that many of required steps inherently involve subjective decision-making. **Appendix J** summarizes some lessons-learned that may support more efficient Systematic Reviews in the face of similar constraints.

7.6.2. *Limitations*.

The meta-analyses of Pearson's correlation coefficients provide an assessment of the strength of the linear relationship of physically-demanding tasks compared to physical fitness tests or test groups. Any non-linear relationships would not be identified by the analyses. The correlation coefficient data available for many of the tasks and fitness components evaluated in our analyses appear fairly robust. Though there are some gaps, it does not appear that additional data sets (correlation coefficients) would yield substantially different correlation results for most tasks and fitness test groups. Limitations are discussed below:

- <u>Publication and Reporting Bias.</u> Because the SR methodology is designed to focus on comparable measures of data for purposes of a meta-analysis, other potentially relevant or critical science can be missed. The use of existing published literature is always subject to publication bias (e.g., more significant findings are more likely to get published than non-significant ones) as well as reporting bias (the selective reporting of certain outcomes). The potential for such bias was minimized by reviewing grey sources and military reports available in DTIC. Because of resource limitations, our review was also limited to English-language studies. Therefore, it is possible that certain applicable data sets were not identified during the systematic process, to include more recent publications (i.e., publications that may have been identified or become available after April 2013). The potential to miss other potentially relevant and/or critical reference articles or reports that did not provide correlation data was offset by utilizing a team of other subject matter reviewers to review including external Army SMEs to access pertinent grey sources.

- <u>Selection bias</u>: The populations represented by the selected studies (e.g., military, firefighters, athletes, healthy adult civilians), are considered an appropriate representation of the overall healthy adult military population. While age, body weight, fitness training and conditioning levels, and motivation were not quantified in this evaluation, the variation in the pooled data sets is considered reasonably similar to that of the overall US Army. The study populations represented more males than female which is also consistent with overall military and Army populations. However, the lack of comparable male and female data limited our analyses of differences in correlations between genders. Another potential aspect of this type of bias is whether the tasks being conducted by these populations are

appropriately similar and representative of military tasks. As previously described in **Section 5.2**, the selection and categorizing of military-relevant physical tasks included the acknowledgement that certain variables are inherently a facet of real-life job performance as long as the tasks fundamentally described a similar activity. For example, the "casualty drag task" category refers to a task that represents a person's ability to rescue a casualty or victim by dragging a body (tested with a mannequin) a certain distance. Key variables in this task include the weight of mannequin, the distance and type of terrain the mannequin needs to be moved. The study variations in quantifying performance of these tasks are not considered substantial. Rather, these variations add strength to this current study as they capture the expected variability of task performance in combat situations.

- Individual Study Biases and Limitations: The small sample size of many of the identified studies is the most notable limitation across the individual studies. While this is balanced by the use of multiple studies using meta-analyses techniques to generate pooled correlation coefficients. Other limitations of the individual studies include incomplete documentation of procedures, or lack of controls for impacts from fatigue or the sequential ordering of events. These limitations were addressed by having two independent reviewers apply the scoring criteria to each study. Though some studies were of higher quality, the 26 studies selected were considered to be of adequate quality for these analyses. While the quality of these studies varied, the overall integrity of the combined data set was maintained as critical data elements described on the criteria scoring sheets were required for each study in order to include the dataset.

8 Conclusions and Recommendations

8.1 General

Although this SR and meta-analyses have limitations, the results can be considered stronger and more credible than that of any narrative review or single study regarding the association between military relevant tasks and fitness tests. The SR process provides a thorough and transparent basis for identification of relevant work. While there is considerable variation in the documented correlations the meta-analyses demonstrate patterns of correlations that cannot readily be explained as artifacts of meta-analytic technique or individual study biases. Moreover, the effects are not so small that they can be dismissed as lacking practical or operational significance. The key conclusions and recommendation are as follows:

8.2 Recommended Physical Fitness Tests

8.2.1. *Basic physical test requirements.*

A basic Army-wide physical fitness test is necessary for the routine monitoring of Soldier's physical capacity to conduct common military tasks. Such a test also provides the means for motivating individual Soldier's to maintain if not improve personal fitness. Such a test or series of tests should provide measures of the physical fitness components most critical to common Army task performance. The test must be in addition to individualized gender- and age-specific medical fitness for duty evaluations, and unit or MOS-specific physical requirements or standards. Our analyses has identified the key common tasks, and provides evidence for associated physical fitness tests that can be described as validated for measuring the fitness components required for these tasks. The benefits of specific tests include consideration of reliability as well as feasibility of administration for Army-wide field implementation. These field expedient tests will not demonstrate that a Soldier has all the *skill*-related physical fitness components necessary to conduct his/her tasks, but can be used to ensure that Soldiers have the basic physical capacity to be trained to conduct basic tasks. The additional advantage of using existing tests includes history of use (no learning curve) and their value in Army injury surveillance studies (to identify populations at risk of injuries as well as attrition). Specific tests are recommended below:

8.2.2. *Cardiorespiratory endurance tests*.

While the 2-mile run itself is not a military task, the physical fitness component (cardiorespiratory endurance) that is measured by this run test is more strongly correlated with performance of key military tasks than any of the other four physical fitness components evaluated. Therefore, a test of Soldiers' basic physical capacity to perform essential tasks should include a cardiorespiratory test. The 2 mile run is considered a valid, reliable, and simple field expedient test. In addition, it has been successfully used for years, both as a measure of aerobic capacity and as a variable for predicting populations at risk of injury. It is therefore suggested that the 2 mile run test be retained.

8.2.3. *Muscle endurance tests.*

- Push-Ups. The current push-up test is also a reasonably reliable, valid, and field expedient test of upper body muscle endurance. As with run times, push test scores have been successfully used as a measure to identify less fit military personnel who are at greater risk of injury. It is therefore suggested that the push up test be retained.

- Sit-ups. Not only were sit up tests weakly correlated to most military tasks evaluated, they have also provided much less valuable measures for screening or predicting Soldier's fitness and injury risk than either the 2 mile run or push-ups. It is recommended that consideration be given to eliminating the sit up test from inclusion in future Soldier physical fitness and readiness testing.

- Gaps. The current APFT does not include a test to measure *lower body* muscle endurance. The data suggest this is an important component that could be measured through fairly reliable field test such as sprint or shuttle tests. As these tests reflect aspects of speed, an alternative test of power (as suggested below) may also be considered as an added future test.

8.2.4. *Muscle strength tests.*

The most notable gap in the current APFT is the lack of a strength test – and especially *lower body* test of muscle strength. Consideration should be given to fill this gap in future testing requirements. Especially since tests of strength that rely on machines or equipment tend to be less field expedient, lower body tests of power or speed may be considered as a feasible alternative. In addition to the sprint or shuttle tests, jump tests such as the SBJ or VJ (for lower body power) are valid, reliable, and field expedient tests that are especially recommended for consideration as an added test.

8.2.5. *Flexibility tests*.

This analysis does not support the use of bend and reach flexibility tests as means to measure required military task performance.

8.3 Test Standards

While this review and analyses provides evidence for the use of specific fitness tests that correlate to performance, it does not provide a basis for test standards (VO_2 max or run times) necessary to perform military tasks. While for most fitness tests males will tend to score higher, tests must be assigned a single set of standards to ensure they are validated against required task performance. The recently established Canadian test provides an example. Standards should be independent of gender and age and instead tied to mission performance (e.g. required times to complete a mission) and /or cut-off limits that have been associated with unacceptable rates of injury or attrition. Unlike the current APFT scoring system, the basis for standards for a military physical test should be clearly documented and transparent for review.

8.4 Relationship to Other Military Physical Requirements

In addition to a modified basic Army fitness test, Army medical fitness and MOS-specific physical requirements should be enhanced. As depicted in **Figure 8-1**, the existing Army Fitness for Duty requirements [56] and MOS-specific indices and Physical Demands categories [57] provide key elements for a tiered approach to assessing and ensuring the physical aptitude of Army Soldiers. Improvements to these procedures could help ensure that individuals are capable of performing their job tasks as well as help minimize injury. Specific recommendations include:

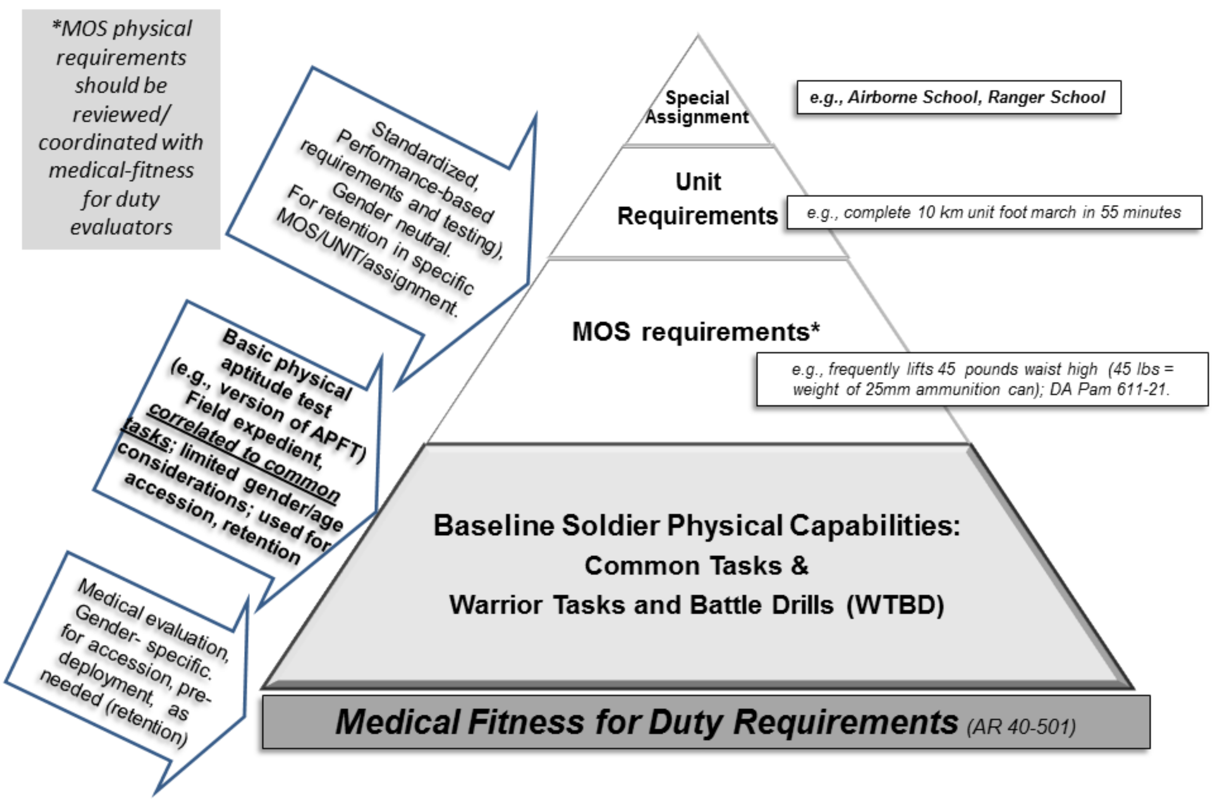
- The existing Army medical fitness for duty requirements already provide age- and gender-adjusted health and fitness determinations for job accession and retention. Including field –expedient physical fitness tests such as those described in this report further enhance the objective criteria by which a base level of job- required physical fitness is determined. Because Army jobs vary in physical demands, and because certain physical tasks can be learned (i.e., are skill –related), it is not clear how useful a minimum set of “gender and age neutral” standards would be for basic accession screening and/or retention monitoring and motivation. The scores from such testing also would continue to provide useful metrics for injury surveillance purposes. While some minimum level of gender neutral ‘physical fitness standards” could perhaps be set, a few broader categories of physiologically justified age- and gender- adjusted standards (as compared with the

existing 5-year age groups) should be considered. For example – male and female categories of <25 years, 25-35 years, and >35 years.

- To ensure personnel can conduct unique job requirements for the more physically demanding jobs and especially direct combat-related positions, more stringent physical fitness tests and or standards should be implemented as the critical "gender-neutral" of job-specific requirements. For example, the same physical fitness tests as described in this report but with more stringent gender-neutral standards could be used MOS-specific physical demands designations (**Appendix C**). Regardless of test criteria used, improved and more accessible and transparent documentation of the rationale for the MOS-specific physical demands and PUHLES criteria are recommended.

- A mechanism (e.g., review panel) to ensure familiarity between medical providers who conduct medical fitness evaluations on individuals) and MOS Proponents who develop PUHLES/Physical demands task requirements.

Figure 8.1 Army Soldier Physical Capability Requirements and Recommendations*



Includes notional modifications to existing requirements and procedures;* **Appendix C, [56, 57].

9 Point of Contact

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APPENDIX A

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APPENDIX B

Past U.S. Army Physical Fitness Tests

Though the current APFT was established in the 1980s, there were many different tests prior that time, and proposals and review for change since then prior the current 2011-2012 proposed tests. This Appendix provides a summary of past tests.

Content is derived from a presentation by Dr. Whitfield (Chip) East, Department of Physical Education - United States Military Academy (West Point) and East 2013 [81].

Table B-1. History of U.S. Army Physical Fitness Tests

Timeframe	Test name	Specific fitness tests	Source
1919 (World War 1)	Individual Efficiency Test (IET)	▪ 100-yd run ▪ Running Broad Jump ▪ 8' Wall Climb ▪ Hand grenade Throw ▪ Obstacle Course Run	Mass Physical Training (1919) – approved by Army War Department
1920 – 1942 (Interwar Years)	*Retained:* IET *But added addition fitness assessment tests*	Primary Assessments ▪ 100-yd Dash ▪ Running High Jump ▪ Running Broad Jump ▪ Pushups ▪ Obstacle Course Test ("OCT") Secondary Assessments ▪ Baseball Throw ▪ Basketball Throw ▪ Bar Vault ¼ mile run ▪ ½ mile run ▪ 2 mile walk ▪ Vertical jump ▪ Pull-ups ▪ 20' rope climb ▪ Stand/Run hop-skip-jump ▪ Standing backward jump ▪ Running long dive	Basic Field Manual - BFM (1936) –Volume I – Chapter 4: Physical Training Field Manual - FM 21-20, Physical Training (1941)
1942 (World War II)	Army Ground Forces Test (AGFT)	▪ Pushups ▪ 300-yd Shuttle Run ▪ 20-sec Burpee Test ▪ 70-yd Pig-a-back Run (carrying Soldier of equal weight) ▪ 70-yd Zig-zag Run(creep, crawl, jump, run) ▪ 4-mile Road March	Army Ground Forces Training Directive (1942)
1944 (World War II)	Physical Efficiency Test Battery (PETB) first time with normative scales (0-100)	▪ Pull-ups ▪ 20-sec Burpee Test ▪ Squat Jumps ▪ Pushups ▪ 100-yd Pig-a-back Run ▪ Sit-ups ▪ 300-yd Shuttle Run	DA Pamphlet 21-9, Physical Conditioning (1944)
1946-mid 50s (Post World War II – Korea)	Physical fitness test batteries (PFTB) – "Outdoor" and "Indoor" versions	PFTB Outdoor Battery ▪ Pull-ups ▪ Squat Jumps ▪ Push-ups ▪ Sit-ups ▪ 300-yd Shuttle Run PFTB Indoor Battery ▪ Pull-ups ▪ Squat Jumps ▪ Push-ups ▪ Sit-ups ▪ Shuttle Run (250 yds)	FM 21-20, Physical Training, 1946 & 1950
1957 (Post Korean War)	*Retained:* **PFTB-Outdoor** *Added:* Physical Achievement Test (PAT) to be administered to "combat type units"	PFTB Outdoor Battery *(see above)* Physical Achievement Test (PAT) ▪ 5-sec Rope Climb ▪ 75-yd Dash ▪ Triple Broad Jump ▪ 150-yd Man Carry ▪ 1-mile Run	**"***As the reports came back from Korea, an alarming number of casualties were attributed to the inability of the U. S. soldiers to physically withstand the rigors of combat over rugged terrain and under unfavorable climatic conditions."* (FM21-20p. 10) FM 21-20, Physical Training (1957) TM 21-200, Physical Conditioning (1957)
1961 (Pre Vietnam War)	*Terminated***:** PETB & PAT *Introduced:* Physical Combat Proficiency Test (PCPT) with minimum performance times/scores	▪ 40-yd Low Crawl ▪ Horizontal Ladder Test (1-min) ▪ Dodge, Run, and Jump ▪ Grenade Throw ▪ 1-mile Run	TM 21-200, Physical Conditioning (1961)
1969 (Vietnam War)	*Retained:* PCPT *And added 3 specialty tests*	PCPT *(see above)* Army Minimum PFT – Male: ▪ squat bender, ▪ sit-ups, ▪ push-ups, ▪ leg over, ▪ burpee, ▪ stationary run Inclement Weather PFT: ▪ push-ups, ▪ knee bender, ▪ sit-ups, ▪ side step (jump jacks) ▪ squat thrust (burpee)	FM 21-20, Physical Readiness Training (1969)

		Airborne Trainee PF Qualification Test: ▪ chin-ups, ▪ bent-leg sit-ups ▪ push-ups ▪ half knee bend ▪ 1-mile run		
1973 (Post Vietnam War)	*Introduced:** ▪ Advanced Physical Fitness Test (APFT) ▪ Staff-Specialist PFT (SSPFT) ▪ Basic PFT (BPFT)	APFT: ▪ inverted crawl ▪ bent leg sit-ups ▪ run/dodge/jump ▪ 2-mile run SSPFT: ▪ push-ups, ▪ bent leg sit-ups, run/dodge/jump ▪ 1-mile run	BPFT (for trainees < 40): ▪ inverted crawl, ▪ bent leg sit-ups ▪ run/dodge/ jump ▪ 1-mile run	FM 21-20, Physical Readiness Training (1973) **also recognized four (4) specialty tests:* → Inclement Weather PFT → Minimum PFT – Male → Airborne Trainee PF Qualification Test → Ranger/Special Forces PF Qualification Test
1975 (Womens' Army Corps)	*Introduced:* **Four physical fitness tests for women:** ▪ Basic PFT ▪ Advanced PFT ▪ Staff-Specialist PFT ▪ Airborne Trainee PF Qualification Test	Basic PFT (basic trainees): ▪ 80m shuttle run ▪ modified pushups (knees) run/dodge/jump ▪ modified sit-ups (crunches) 0.5-mile run Staff-Specialist PFT: ▪ 80m shuttle run ▪ modified pushups (knees) run/dodge/jump modified sit-ups (crunches) ▪ stationary run	Advanced PFT: ▪ 80m shuttle run ▪ modified pushups (knees) run/dodge/jump, ▪ modified sit-ups (crunches) 1-mile run Airborne Trainee PF Qualification Test: ▪ incline chin-up (~45^{o} angle) modified pushups ▪ modified sit-ups ▪ knee bender ▪ 1-mile run	FM 35-20, Physical Fitness for Women (1975)
1980-84 (Cold War Physical Readiness Training (PRT))	*Introduced :* Army Physical Readiness Test (APRT) – later renamed to Army Physical Fitness Test (APFT) 3-event, first gender integrated test; age groups *Stipulations:* easy to administer (administer anywhere) and minimal need for equipment	Soldiers (ages 17-39): ▪ Push-up ▪ Sit-up ▪ 2-mile Run Soldiers (ages 40-60): ▪ 2-mile run or alternate cardio event ▪ **>** 40 years/age not allowed to test PU or SU		FM 21-20, Physical Readiness Training (1980) → Supersedes FM 21-20 (1973) and FM 35-20 (1975) → 1982 – U.S. Army Soldier Physical Fitness Center – FT Ben Harrison → 1983 – Master Fitness Trainer Course (6P– ASI)
1986	APFT: *Scoring standards were changed to 5-year age increments*	▪ *1986 - Minimum performance scores (60-pt score) for 17-21 year old men and women changed significantly* ▪ *The 60-pt scoring standards (for ages 17-21):* *Men PU = 42, SU = 52, 2MR = 15:54* *Women PU = 18, SU = 50, 2MR = 18:54*		Physical Fitness Training (Change 1, FM 21-20, 1986 ** TC 3-22.20 – implemented Army wide in August 2010 with no change to the APFT events
2002	*Proposed APRT – 6 event*	*not approved*		

APPENDIX C

Other Army Physical Capability Requirements

C-1. Army Medical Fitness Standards

The Army's Physical Profile Serial System includes specific medical standards for Physical capacity (P), Upper extremities (U), Lower Extremities (L), Hearing (H), Eyes (E), and Psychiatric (S) criteria to ensure that Soldiers are medically qualified to perform the duties of their assigned job [56]. This "P-U-H-L-E-S" profile system is used to match functional capacity of individual Soldiers to the functional requirements of specific Army jobs (e.g. MOS). The profile is based upon the function of six body systems and their relation to military duties. The six factors that make up this system are described in **Table C-1**. Four numerical designations (1, 2, 3, or 4) are used to reflect different levels of functional capacity for each of the each of the six factors. For example, the current PULHES for a 11C Infantryman a serial profile of "111221," that means, in order to qualify for that job, a person would have to be medically rated at least a "1" in the area of "Physical capacity or stamina," a medical rating of "1" in the area of "Upper extremities," as well as "Lower extremities," a rating of "2" in the area of "Hearing and Ears," and "Vision," and a "1" for Psychiatric.

The four numerical ratings that are assigned to individual Soldiers are based on a military medical evaluation where:

- "1" reflects a high level of medical fitness.
- "2" indicates some medical condition or physical defect that may require some activity limitations.
- "3" signifies one or more medical conditions or physical defects that may require significant limitations. This designation can be a primary basis disqualification for individuals applying for entry into Service. For individuals already in the service, this designation typically results in limited duty assignments commensurate with his or her physical capability.
- "4" indicates that the individual has one or more medical conditions or physical defects of such severity that performance of military duty must be drastically limited. A disqualifier for both entering the military, and usually also for continued military service.

Table C-1. Six Functional Evaluation Factors of the Army's Physical Profile Serial System

Function		Description
P	Physical capacity or stamina	General physical capacity, includes conditions of the heart; respiratory system; gastrointestinal system, genitourinary system; nervous system; allergic, endocrine, metabolic and nutritional diseases; diseases of the blood and blood forming tissues; dental conditions; diseases of the breast, and other organic defects and diseases that do not fall under other specific factors of the system
U	Upper extremities	Concerns the hands, arms, shoulder girdle, and upper spine (cervical, thoracic, and upper lumbar) in regard to strength, range of motion, and general efficiency
L	Lower extremities	Concerns the feet, legs, pelvic girdle, lower back musculature and lower spine (lower lumbar and sacral) in regard to strength, range of motion, and general efficiency.
H	Hearing and ears	Concerns auditory acuity and disease and defects of the ear.
E	Eyes	Concerns visual acuity and diseases and defects of the eye.
S	Psychiatric	Concerns personality, emotional stability, and psychiatric diseases

AR 40-501, as derived from Department of Defense (DOD) Instruction 6130.03, *Medical Standards for Appointment, Enlistment, or Induction in the Military Services* [56, 131].

The first factor (Physical capacity or stamina) is especially of particular relevance to this systematic review. Physical capacity and stamina is considered addressed by the cardiorespiratory physical fitness component. Functionality of Upper extremities and Lower extremities are also relevant to determining physical capacity to perform job duties. The separate medical evaluation of Upper and Lower extremity functional capacity for job duties was considered especially relevant to evaluation of muscular strength and muscular endurance described in this report. The specific rating criteria for these three factors are summarized in **Table C-2**.

Table C-2. Basis for Rating of Specific Factors of the Army Physical Profile Series

PUHLES Factor	Rating	Basis
P- Physical capacity or stamina	1	Good muscular development with ability to perform maximum effort for indefinite periods.
	2	Able to perform maximum effort over long periods.
	3	Unable to perform full effort except for brief or moderate periods.
	4	Functional level below the standards of "3."
U- Upper extremities	1	No loss of digits or limitation of motion; no demonstrable abnormality; able to do hand to hand fighting.
	2	Slightly limited mobility of joints, muscular weakness, or other musculo-skeletal defects that do not prevent hand–to–hand fighting and do not disqualify for prolonged effort.
	3	Defects or impairments that require significant restriction of use.
	4	Functional level below the standards of "3."
L- Lower extremities	1	No loss of digits or limitation of motion; no demonstrable abnormality; able to perform long marches, stand over long periods, run.
	2	Slightly limited mobility of joints, muscular weakness, or other muscular-skeletal defects that do not prevent moderate marching, climbing, timed walking, or prolonged effort.
	3	Defects or impairments that require significant restriction of use.
	4	Functional level below the standards of "3."

AR 40-501, as derived from Department of Defense (DOD) Instruction 6130.03, *Medical Standards for Appointment, Enlistment, or Induction in the Military Services* [56, 131].

C-2. Military Occupational Specifications (MOS) PUHLES Profile and Physical Demands Rating

Currently the Army has over 200 MOSs divided into Combat, Combat Support, and Combat Service Support Categories [57]. The MOS descriptions are associated with both an MOS PUHLES index profile and a Physical Demands rating. The MOS description, PUHLES index, and physical demands ratings are intended to be gender-neutral and are to be updated as demands/tasks change. While TRADOC provides guidance to score and rate MOS PUHLES and Physical Demands, previous evaluation has indicated that MOS- specific physical demands ratings may be inconsistently determined [80].

Unlike an *individual Soldier's medical PUHLES* profile, an *MOS- PUHLES index profile* is not determined by medical personnel. The MOS PUHLES index is determined by a designated Army proponent for the type of MOS (e.g., a designed person/office defines PUHLES for infantry MOS, another provides profiles and ratings for medical MOS, another for intelligence MOS, etc.) [132, 133].

For the MOS Physical Demands ratings, the Army uses the five Department of Labor occupational physical demands ratings/categories as modified by the U.S. Army Women in the Army (WITA) Policy Review [26]. These categories are described in **Table C-3**. The MOS is assigned a Physical Demands rating based on a detailed physical demands analysis of the typical physical work requirements for that MOS (per DA Form 5643-R) [58]. **Figures C-1** and **C-2** present descriptions of physical task requirements for examples of MOS' that have excluded females (**Figure C-1**) and MOS' that are open to women (**Figure C-2**). The most demanding of the tasks for each MOS are to serve as the basis for the Physical Demands rating for that MOS. A key objective of MOS Physical Demands Analysis is to ensure a gender-free process is used to determine individual job assignments.

Table C-3. Army MOS Physical Demands Categories, per DA Pam 611-21 [58]

Army MOS physical demands ratings/categories	
LT - Light	- Occasional lifting of a maximum of 20 pounds - Frequent or constant lifting of 10 pounds
MD - Medium	- Occasional lifting of a maximum of 50 pounds - frequent or constant lifting of 25 pounds
MH - Moderately Heavy	- Occasional lifting of a maximum of 80 pounds - frequent or constant lifting of 40 pounds
HV - Heavy	- Occasional lifting of a maximum of 100 pounds - frequent or constant lifting of 50 pounds
VH - Very Heavy	- Occasional lifting of *over* 100 pounds - Frequent or constant lifting *in excess of* 50 pounds
Definitions of physical demands adjectives (probability of occurrence)	
Occasional	- *occurring or appearing at irregular or infrequent intervals* - *occurring now and then*
Frequent	- *happening or occurring at short intervals*
Constant	- *continuing without pause or letup, unceasing;* - *regularly recurrent, continual or persistent*

Figure C.1 Example Physical Requirements for MOS That Have Been Closed to Women, per DA Pam 611-21 Table 10-5 [58]

MOS DESCRIPTOR INFORMATION			PULHES Index	Physical Demand
13B1 CANNON CREWMEMBER	**B 197310**	**E3 E4**	**112211**	**VH**

1. Frequently lifts 184 pounds 3 feet and carries 6 feet as part of a 2 soldier team (prorated 97 pounds/ soldier).
2. Frequently lifts 243 pounds 2 feet and carries 30 feet as part of a 2 soldier team (prorated 121.5 pounds/ soldier).
3. Constantly lifts 200 pounds 3 feet and carries 4 feet as part of a 2 soldier team (prorated 100 pounds/ soldier).
4. Constantly utilizes visual sighting devices.
5. Must possess red/green color discrimination.

13D1 FIELD ARTILLERY AUTOM	**B 199804**	**E3 E4 S**	**222221**	**MH**

1. Occasionally lifts/lowers 350 pounds 8 feet as part of a 4 soldier team (prorated at 87.5 pounds/ soldier).
2. Occasionally lifts/lowers 313 pounds up/down 5 feet and carries 10 feet as part of a 4 soldier team (prorated at 78.l2 pounds/ soldier).
3. Occasionally lifts/lowers 150 pounds 6 inches as part of a 2 soldier team (prorated at 75 pounds/ soldier).
4. Frequently carries 100 pounds 15 feet as part of a 2 soldier team (prorated at 50 pounds per soldier).
5. Occasionally lifts/lowers and carries 50 pounds 3 feet.
6. Must be able to hear a wide range of human voice tones through headphones.
7. Frequently reads complex technical manuals.
8. Must possess red/green color discrimination.
9. Must possess finger dexterity in both hands.

13T1 FIELD ARTILLERY SURVE	**B 201004**	**E3 E4 S**	**222221**	**VH**

1. Occasionally lefts 275 pounds 30 inches and carries up to 30 meters as part of a 2 Soldier team (prorated 137.5 pounds per Soldier). Must lift 100 pounds for 300 meters.
2. Occasionally pull up to 83 pounds 36 inches. Frequently lifts 50 pounds and carries 10 meters.
3. Must possess normal color vision.
4. Must possess finger dexterity in both hands.
5. Frequently reads complex schematic diagrams.
6. Must be able to hear a wide range of human voice tones.

14S1 AIR AND MISSILE DEFEN	**B 199010**	**E3 E4 S**	**111211**	**HV**

1. Frequently lifts and lowers 50 pound 3 feet.
2. Frequently carries 50 pound 164 feet.
3. Frequently pushes and pulls 50 pound 2 feet.
4. Frequently climbs 6 feet.
5. Frequently runs up to 45 feet carrying 38 pound.
6. Must possess finger dexterity in both hands.

18D3 SPECIAL FORCES MEDICA	**B 198310**	**E6 E6 S**	**111221**	**NA**:

1. Frequently visually identifies vehicles, equipment and individuals at a long distance.
2. Occasionally raises and carries 160 pounds person on back.
3. Frequently performs all other tasks while carrying 65 pounds evenly distributed over entire body.
4. Frequently digs, lifts and shovels 21 pounds scoops of dirt in bent, stooped or kneeling position.
5. Frequently gives and receives oral commands in outdoor area from distance of 50 meters.
6. Frequently walks, crawls, runs, and climbs over varying terrain for a distance of up to 25 miles.
7. Frequently runs for short distances.
8. Frequently walks at a brisk pace 4 out of 6 hours while carrying 26 pounds.
9. Frequently throws 1 pound object up to 40 meters.

Figure C.2 Examples of Physical Requirements for MOS Open to Women

MOS DESCRIPTOR INFORMATION			PULHES Index	Physical Demand
35T1 MILITARY INTELLIGENCE	**B 200704**	**E3 E4 T**	**222221**	**MD**

1. Occasionally lift and lower 90 pound a distance of 3 feet (as part of a 2 Soldier team prorated 45 per Soldier).
2. Occasionally lift 90 pound and carry a distance of 50 feet (as part of a 2 Soldier team prorated 45 per Soldier).
3. Occasionally push and pull 100 pound distance of 100 feet (as part of 2 Soldier team (prorated 50 lbs/per Soldier
4. Frequently kneels, stoops, crouches 30 to 90 minutes.
5. Frequently sits or stands 1 to 5 hours.
6. Must possess auditory acuity.
7. Must possess normal color vision and good near vision.
8. Must possess finger dexterity in both hands.
9. Must possess hand/eye coordination.

88M1 MOTOR TRANSPORT OPERARATOR	**B 198704**	**E3 E4**	**222222**	**VH**

1. Occasionally lifts and pulls 130 pounds.
2. Constantly lifts and pivots 342 pounds as part of a 2 soldier team (prorated 171 pounds per soldier).
3. Must possess red/green color discrimination.
4. Constantly listens to engines to detect unusual sounds.
5. Frequently reads maps, signs and signals.

92Y1 UNIT SUPPLY SPECIALIS	**B 199304**	**E3 E4**	**222222**	**HV**

1. Frequently lifts, lowers and carries 100 pounds.
2. Occasionally carries 100 pounds up to 500 feet.
3. Frequently pushes/pulls 100 pounds 200 feet.
4. Must possess normal color vision.
5. Frequently writes to keep records and compile data.
6. Frequently inventories visually.
7. Frequently reads detailed technical manuals.

68S1 PREVENTIVE MEDICINE S	**B 200604**	**E3 E4**	**222221**	**MH**

1. Frequently required to lift up to 60 pounds with frequent lifting and carrying of up to 40 pounds.
2. Frequently write reports and compiles data.

68Q1 PHARMACY SPECIALIST	**B 200604**	**E3 E4**	**222221**	**MH**

1. Frequently lifts 40 pounds and carries long distances.
2. Occasionally lifts 80 pounds and carries short distances.
3. Frequently pushes 400 pounds on wheels for long distances.
4. Must possess normal color vision.
5. Must possess finger dexterity in both hands.

35T1 MILITARY INTELLIGENCE	**B 200704**	**E3 E4 T**	**222221**	**MD**

1. Occasionally lift and lower 90 pound a distance of 3 feet (as part of a 2 Soldier team prorated 45/ Soldier).
2. Occasionally lift 90 pound and carry a distance of 50 feet (as part of a 2 Soldier team prorated 45/ Soldier).
3. Occasionally push and pull 100 pound distance of 100 feet as part of a 2 Soldier team (prorated 50/ Soldier)
4. Frequently kneels, stoops, crouches 30 to 90 minutes.
5. Frequently sits or stands 1 to 5 hours.
6. Must possess auditory acuity.
7. Must possess normal color vision and good near vision.
8. Must possess finger dexterity in both hands.
9. Must possess hand/eye coordination.

APPENDIX D

Previously Suggested Key Military-Relevant Physical Fitness Components and Example Physical Fitness Tests

Figure D-1. Military Tasks and Physical Fitness Components with Most SME Votes[1]

Military Tasks	Strength	Power	Endurance	Body Composition	Coordination	Balance	Agility	Flexibility	Aerobic Fitness	Speed	Reaction Time
Jump or leap over obstacles	7.5	9	4	6.4	6.9	5.7	6.5	5.9	2.6	5.7	4
Move with agility-coordination	4.7	5.4	5.5	5.8	9.5	8.4	9.8	6.1	4.1	6.5	6.6
Carry heavy loads	8.8	6.2	7.5	5.2	3.7	5	2.9	3.3	5.5	2.2	1.6
Drag heavy loads	9.2	7.4	7.4	5.2	4.5	4.8	3.3	3.8	5.2	2.7	1.6
Run long distances	3.8	3.1	6.9	6.9	3.2	3.2	3	3.2	9.9	4	1.4
Move quickly for short distances	6	7.8	5	6.2	7	6.4	7.8	4.4	4	9.3	6
Climb over obstacles	8.3	6.5	5.7	6.7	7	6.1	6	5.9	3.9	4.1	2.2
Lift heavy objects off ground	9.7	7.7	5.4	5.5	4.8	5.1	2.7	5	3	2.3	1.6
Load/stow/mount hardware	7.7	6	6.3	5	5.7	5.3	3.4	4.9	3.6	2.6	2.2
Overall mean	7.3	6.6	6	5	5.8	5.5	5	4.7	4.6	4.4	3

[1] Results of the voting from the April 18-19, 2013, National Strength and Conditional Association (NSCA) Blue Ribbon Panel of 20 Subject Matter Experts (including experts from U.S. Army, Air Force, Marine, Navy, and academia) [65].

Figure D-2. Field Expedient Test Types with Most Votes[1]

Fitness Component	Field Expedient Options
Aerobic Fitness	Running Test
	Beep Test
Muscular Strength	Isometric Dynamometer
	Pull-Up
	Incremental Dynamic Lift
	Push-Up
Muscular Endurance	Push-Up
	Burpee (Squat Thrust)
	Squat
Flexibility	Functional Movement Screen
	Sit and Reach
	Y-Balance
Body Composition	Circumference Measurements Bod Pod
Speed	40-Yard Sprint
Agility	300-Yard Shuttle Run
	T-Test Agility Drill
Power	Standing Broad Jump
	Vertical Jump
	Medicine Ball Throw
Coordination	Sit-Up and Stand w/o using Hands Burpees
Balance	Beam Walk
	Y-Balance
Reaction Time	N/A

[1] Results of the voting from the April 18-19, 2013, National Strength and Conditional Association (NSCA) Blue Ribbon Panel of 20 Subject Matter Experts (including experts from U.S. Army, Air Force, Marine, Navy, and academia) [65].

Table D-1. Example Physical Fitness Tests by Physical Fitness Component

(adapted from Knapik, 2004 [67]*)*

Fitness Component	Fitness Sub-component	Reported Reliability and Validity of Various Physical Fitness Tests Per [#] studies			
CARDIO-RESPIRATORY ENDURANCE ♦Most tests are run tests ♦Reliability (R) of tests reported: Several appear good to very good ♦Validity (V) of tests reported: VO_2 Max is the gold standard physiological measurement (< 1 mile not as good, 1 M good, > 2 M best)	**Aerobic fitness**	**Speed/distance or sustained force/power**			
		0.3*M-2.0 M	0.82-0.92 [4]	*(see **Table 7-1** of this report for presentation of validity to VO_2 Max)*	
		1.2 M- 3.1 M	NA		
		4.0M-26.0 M	NA		
		D. in 5 -12 min	0.78-0.94 [11]		
		Shuttle Run*	0.87-0.98 [2]		
		** short distances have also been evaluated for "anaerobic" component*			
(Anaerobic)*		600yd (.3) mile run*	.87 [1]		
		Anaerobic Shuttle	0.85 [1]		
		30 /50/60 yd dash	0.88-0.97[3]		
MUSCULAR ENDURANCE ♦ Can be tested either statically (as to fatigue) or dynamic (per time) ♦ Can use absolute (fixed load) or relative loads ♦ Reliability of tests reported: Several appear good to very good ♦ Validity of tests reported: Cannot be measured as there is no single physiological measurement	**Dynamic strength**	**Short-term sustained force or average power**			
		Upper Body focus		**Lower Body focus**	
		Bench press	0.90 [1]	Leg press	0.68 [1]
		Rowing Reps	0.80 [1]	Leg Lifts	0.67-0.95 [4]
		Hand grip	0.60 [1]	Squat thrust	0.7—0.87 [4]
		Pull ups	0.88-0.95 [7]	Deep Knee Bend	0.85 [1]
		Modified girl pull up	0.82 [1]		
		Dips	0.77-0.92 [4]		
		Push Ups	0.76-0.88 [3]		
		Flex arm hang	0.74-0.83 [3]		
	Trunk	**Short-term sustained force or average power**			
		Sit ups	0.57-0.72 [3]	Hold Half Sit	0.88 [1]
STRENGTH ♦ Can be tested either statically or dynamically as maximum force or power exerted ♦ Conflicting data over separate upper, lower, and trunk strength ♦ Reliability of tests reported: Several appear good to very good ♦ Validity of tests reported: Cannot be measured as there is no single physiological measurement	**Static Strength**	**Maximal force** (Isometric tests)			
		Upper Body		**Lower Body**	
		Hand grip	0.75-0.95 [7]	Plantar Flexion	0.83[1]
		Upright pull	0.97 [1]	Knee Extension	0.94-0.98 [2]
		Wrist Flexion	0.83-93 [2]	Isometric squat	0.97 [1]
		Elbow flexion	0.94-0.98 [3]		
	Power Explosive power	**Maximal force (**Dynamic/isoinertial)			
		Bench Press	0.88-.99 [3]	Dynamic Squat	0.94 [1]
		Maximal power (projection of object or person)			
		Baseball/Softball throw	0.91-0.93 [2]	Bar snap	0.92 [1]
		Medicine ball throw	0.70-0.73 [2]	Rope climb	0.80 [1]
		Shot put	0.90-.97 [3]	Vertical Jump	0.80-.98 [3]
				Broad jump	0.76-0.96 [3]
				Running High jump	0.96 [1]

APPENDIX E

Selected Studies and Extracted Data with Review Scores

Table E-1. Selected Studies and Extracted Data with Review Scores

Author	Pub Year		Country	Study Type	Population Type	Population Description	Sample Size	Age	Gender	Statistical Analyses Used	Comparison criteria [Physical tests/measurement type(s)]	Performance Task(s) /Simulation Evaluated	Associated Military Common Task(s)	Relevance to US Army Common task (Direct; Indirect-Good; Indirect - Weak; None)	Significant (Single Test-Task) Correlation Strength(s)	STATS FINDINGS	SCORE
Aandstad, Anders	2011	Validity and Reliability of the 20 Meter Shuttle Run Test in Military Personnel	USA	Lab/Other study	Military_US_Other	Home Guard and AF Cadets	42	34.8 + 4.0	Male-all	Intraclass coorrelation; Pearson correlation coefficient	VO2 max	Shuttle run (20 m)	Move under fire (Run fast < 400m w/without COD)	Good - Comparison with surrogate task for relevant	Strong - Ext Strong	Relaiability (Shuttles completed vs est VO2 max) = 0.96 Validity (equations based) = 0.69	**13**
Arvey, Richard	1992	Development of Physical Ability Tests for Police Officers: A Construct Validation Approach	USA		Civilian_US_fire/haz/pol	96 men and 19 females	115	35.4 + 8.8	Mixed	latent variable anayalses and correlations	Grip SU Bench Dips 1 mile run 100 yard dash	Obstacle course Dummy wrestle Dummy Drag	Push/Pull heavy equipment Lifting carrying equipment/supplies Casualty	Good - Comparison with surrogate task for relevant	Moderate - Strong	Obstacle course: Grip = .26, 100y = .37 Dummy wrestle: (all strong except SU/BD Mod) Dummy Drag: (all strong except SU/BD Mod)	**15**
Barnes, Jacque	2007	Relationship of Jumping and Agility Performance in Female Volleyball Athletes	USA	Lab/Other study	Civilian_US_other	female collegiate volleyball players	29	20± 2	Female-all	Intraclass coorrelation; Pearson correlation coefficient	**(AG)** Countermovement jump [CMJ] with platform measurements) Drop Jump [DJ]	Agility test (four 5 m sprints with 3 180d turns)	Move under fire (Run fast < 400m w/without COD)	Good - Comparison with surrogate task for relevant	Strong (>0.3 < 0.7)	Table 4: CMJ correlation to agility test time= 0.58 DEFINITION: "agility [is] the ability to change direction with a minimal loss of control and/or average speed."	**17**
Beckett, M	1988	Lifting and Carrying Capacities Relative to Physical Fitness Measures	USA	Lab/Other study	Military_US_Navy	64 men and 38 women Navy personnel	102	20-35	Mixed	Multiple regression	Sit and Reach Sit Up 1.5M Run Push Up* Vertical Jump Pull Up Standing Broad Jump (SBJ)* 100-m sprint* ILM lift & press to 152cm ILM Endurance Hold	Box (small metal box, 34 kg) carry (51.4 m distance); timed total no. trips Box lift (to elbow height, & to knuckle height)	Lifting carrying equipment/supplies	Strong- Direct task/simulated task comparison	Mod - Very Strong	Table 4: Sit and Reach: -.01, -.21, -.18 Sit Up: .31, .00, .06 1.5M Run -.67, -.34, -.36 Push Up*: .56, .63, .58 Vertical Jump: .39, .50, .53 Pull Up: .55, .62, .58 SBJ: 0.45, .69, .73 100-m sprint*: -.54, -.62, -.64 ILM press to 152cm: .50, .89, .85 ILM Endurance Hold: -.04,-.23,-.22	**15**
Bilzon J. L. J et al	2002	Generic task-related occupational requirements for Royal Naval personnel	UK	Lab/Other study	Military_Foreign	Three studies described: focus on TBT3 was focused on for this: 52male and41 female Royal Navy personnel	93	?	Mixed	Pearson correlation coefficient	**(MS/P)** Grip strength (?) Upright pull SLJ **(ME/AN)** Pull ups Press-ups Sit-ups 20 m shuttle sprints (max 2 min)	Casualty carry (free carry (FC)) Stretcher carry (SC)	Casualty drag(CD)	Good - Comparison with surrogate task for relevant task	Strong - VeryStrong	Table 4: **SBJ (FC=0.84, SC=.81)** **GS (0.71; 0.71)** UpPull (0.77; 0.79) 2.4 run (0.62; 0.62) 20mshuttle (0.60; 0.56) SU (0.56; 0.58) PressUp (0.69; 0.70) PullUp (0.72; 0.72) EQUATION for FC= r = 0.89	**15.5**
Davis, Paul	1982	Relationship between simulated fire fighting tasks and physical performance measures	USA	Lab/Other study	Civilian_US_fire/haz/pol	professional firefighters	100	21-57 (31.1±)		canonical correlation analyses/factor loading multiple regression analyses	Combined handgrip** Sit Up** Push Ups** SLJ* Chin ups Flexibility ANTH(Age, H,W,LW,%BF) CVM [VO2Max,HR,BP,etc]	Ladder extension Standpipe (33.1kg_ hose lift and carry 5 flights stairs) Hose pull (23.5kg) Simulated rescue 53kg dummy from	Lifting carrying equipment/supplies Casualty drag(CD)	Good - Comparison with surrogate task for relevant task	Regression Model	Table 4. equations evaluated wit hmultiple regression and * variables best predictors for overall performance of (all) tasks. 0.9 included CV measurements and jump**; without CV and Jump was 0.54*	[6.5]

Deakin, J.M.	2000	Development and Validation of Canadian Forces Minimum Physical Fitness Standard	CAN	Lab/Other study	Military_Foreign	military personnel (416 men, 207 female) 3 locations across services (army, navy, AF) july 1998-99	623	32.5±6.4	Mixed	Pearson correlation coefficient loading factor analayses	Sit Up* Push Ups* Combined handgrip* Vertical Jump* Leg Dynometer* USBD Push USBD Pull Chin ups Back Dynamter CVM [VO2Max]	Low/high crawl (30m/45m w/ rifle) Land evac (Strecher carry 41kg 750 m) Sea evacuation (stretcher) Trench Dig	Lifting carrying equipment/supplies	Strong-Direct task/simulated task comparison	Mod - Very Strong	Table 5.4- 5.7; also separtes out females to see different variables 9 eg chin up more relevant predictor factor for males). Overal key factors for bot males and female (VO2 max) are * Sit Up *Push Ups* Combined handgrip* Vertical Jump* Leg Dynometer*	**14.5**
Frykman, P.N.	2000	Correlates of Obstacle Course Performance Among Female Soldiers Carrying Two Different Loads	USA	Lab/Other study	Military_US_Army	volunteer female soldieres overal good shape	11	25.3 ± 5.5	Female-all	correlation coeeficent	AFPT score Sit up Push up VO2Max	Obstacle Cource: 14kg Load & 27 kg Load Hurdles Zig Zag - no corr Low crawl Pipe traversal Sprint	Move >400m <3 mile w load	Strong-Direct task/simulated task comparison	Strong (>0.3 < 0.7)	14kg & 27 kg: Hurdles Anth & Anth Zig Zag none & Anth, VO2, APFT(-.59) Lcrawl SU -.60/PU-.59**&**SU -.55, APFT -.67 Pipe APFT .57/ SU.64/PU.58 **&** VO2 Sprint none & none OBST TM: SU-.62/PU-.54 & APFT -0.57	**15.5**
Harman, Everett	2008	PredictionOfSimulatedBattlefieldPhysicalPerformanceFromFieldExpedientTest	USA	Lab/Other study	Civilian_US_other	"..civilian males , from varied educational and professional backgrounds who met US Army height weight induction criteria."	32	18-35 (28.0 4.7 yrs)	Male-all	Pearson Product Correlation (r); Stepwise multiple linear regression	ANTH(H, BM) VJ HorizJ(SBJ) PU SU 3.2km run	4 simulated battlefield w battle field dress (~18 kg): 400-m shuttle run w 2 turns (urban battle site) 30 m rushes (e.g. 5 times prone/stop/COD) Obstacle course (wall, pipe, stairs,	Move under fire (Run fast < 400m w/without COD) Casualty drag(CD) 80kg 50 m Scale/crawl overal obstacles/terrain Jump up/down/over	Direct task/simulated task comparison	Strong - VeryStrong	CD = only ANTH(BM) 400 mRun = VJ(-.54), SBJ(-.43), PU -.51, 30mRsh= VJ(-.72), SBJ(-.60, PU -.38, SU(-.37), 2M(0.53) OBST= VJ(.62), SBJ(-.69, PU(-.43), SU(-.57), 3.2M(0.57) VJ most significant predictor variable	**13.5**
Hoffman	2009	Physical Readiness Standards Validation for Nevada P.O.S.T. Category III	USA	Lab/Other study	Civilian_US_fire/haz/pol	peace officers, Nevada (103 male, 25 female)	128	?	Mixed	Regression	1.5 M Run (aerobic power) SitReach (flexibility) 1minBent LegSitUp (trunk endurance) PU (upper body endurance) 300mR (anerobic capacity/speed) VJ (leg power) Illinois Agility Run (aglity and coordination) IRM BP (upper body	Lift/carry/drag scenario SC1: run, pick up Fire Ext, run, run up&down stairs, move 165 dummy 50ft Pursuit/backup/pursue SC2: run, serpintine, stairs, fall, dummy roll&drag, strike, cuff	Move under fire (Run fast < 400m w/without COD) Casualty drag(CD) Scale/crawl overal obstacles/terrain Jump up/down/over Push/Pull heavy equipment	Good - Comparison with surrogate task for relevant task	Regression Model	CLUSTER Regression: SC1 =0.61 {BP, 300m, 1.5M run} SC2=0.56 {VJ, BP, 300m run} "essential physical functions .. readiness levels required to perform those unique tasks. ...performed infrequently and often without notice. ....." SEE TABLE C6: JOB TASKS RATED FREQUENT OR CRITICAL and Table C7 (groups)(compare to military)	**11**
Knapik, Joseph	1999	Physiological factors in stretcher carriage performance	USA	Lab/Other study	Military_US_Army	soldiers 7 male and 4 female; 4 medic (3 f), 3 repair/maintenance	11	?	Mixed	Forward stepwise linear regression	ANTH SQUat LatPulls Bench Press Right HandGrip LeftHandGrip SU PU	carriage (time) 82lb mann treadmil 4.8k/h	Lifting carrying equipment/supplies	Good - Comparison with surrogate task for relevant task	Very Strong (>0.7 <0.9)	Significant: Lat pulls= 0.77 Bench Press= 0.70 Right hand Grip= 0.63 Left Hand grip=0.73	**15.5**
Kraemer, William	1998	Prediction of Military Relevant Occupationsl Tasks in Women from Physical Performance Components	USA	Lab/Other study	Military_US_Other	female civilian volunteers medicall screened	123	23 ± 4	Female-all	simple and multiple regression	ANTH 1RM BP (strength) SquatEndur (SE)(leg endurance) HighPull (HP) PU (upper endurance) 1RM Squat Jump Power (JP)w/ weight 2MR	Repetitive Box Lift Task (RBLT) 2M carry 34.1kg ruck (Load bearing task(LBT-endurance	Move >400m <3 mile w load Lifting carrying equipment/supplies	Good - Comparison with surrogate task for relevant task	Moderate - Strong	Most signif aside from ANTH are described by clusters (equation) RBLT: SE (.55), JP (.47), BL (.54), 2MR (-.54) LBT: SE (.46), 2MR (.60)	**9.5**

Author	Pub Year		Country	Study Type	Population Type	Population Description	Sample Size	Age	Gender	Statistical Analyses Used	Comparison criteria [Physical tests/measurement type(s)]	Performance Task(s) /Simulation Evaluated	Associated Military Common Task(s)	Relevance to US Army Common task (Direct; Indirect- Good; Indirect - Weak; None)	Significant (Single Test-Task) Correlation Strength(s)	STATS FINDINGS	SCORE
McBride, Jeffrey	2009	Relationship Between Maximal Squat Strength and Five, Ten, and Forty Yard Sprint Times	USA	Lab/Other study	Civilian_US_other	divisiion 1-AA football players	17	?	Male-all	independent t-test Pearson correlations	ANTH (BM) 1RM SQ	5 yard sprint 10 yd Sprint 40 yard sprint	Move under fire (Run fast < 400m w/without COD)	Weak/Unclear- Task is generic test for physical capacity/function	Strong but requires ration w/BM	40 m = -0.61 (1RM/BM) 10 m= -0.54(1RM/BM) 5M= not signif	**13.5**
Mello, Robert	1988	The Physiological Determinants of Load Bearing Performance at Different March Distances	USA		Military_US_Army	active duty rfle platoon 7th Infantry	28	#######	Male-all	anova and Pearsons	Hamstring and Quads flexion on	2KM 4KM 8KM 12KM with 46 kg loads	Move >400m <3 mile w load >3 mile w load (6, 8 M)	Strong- Direct task/simulated task comparison	Mod - Very Strong	Variable 2KM 4KM 8KM 12KM Q-EXT 300 -.080 -.150 -.462 -.447 Q-EXT1800 -.140 -.240 -.402 -.340 Q-EXT PT -.120 -.250 -.5O8* -.490* Q-EXT MT -.050 -.070 -.641* -.403 H-FLX 300 -.040 -.320 -.533 -.591* H-FLX 1800 -.140 -.180 -.537* -.332 H-FIX PT -.080 -.270 -.608* -.480* H-FLX MT -.180 -.220 -.504* -.553*	**17**
Michaelides, Marcos	2011	Assessment of Physical Fitness Aspects and Their Relationship to Firefighters' Job Abilities	USA	Lab/Other study	Civilian_US_fire/haz/pol	professional male firefighters ; wore protective gear during AT	90 (67)	22-55	Male-all	Pearson Product Correlation multiple linear regression	Step test Sit Up (SU) 1RM Bench Press (BP) 1RM SQUAT Sum hand grip	Ability Test (AT) (all events, timed): Stair Climb 12 steps 8 times Rolled hose (6 ~10 kg) lift & carry 4m to table and back Keiser sled'sledgehammer Hose pull& hydrant hook up Casualty rescue (82 kg,16 m) Charged hose	Climb uphill/stairs Jump up/down/over Push/Pull heavy equipment Move under fire (Run fast < 400m w/without COD) Casualty drag(CD)	Good - Comparison with surrogate task for relevant task	Moderate - Strong	Step test= (-.40) PU= (-.27) 1RMBP= (-.31) SU= (- .41)	**13.5**
Michaelides, Marcos	2008	Predicting Performance on a Firefighter's Ability Test From Fitness Parameters	USA	Lab/Other study	Civilian_US_fire/haz/pol	experienced firefighters from AR	38	2.25 + 6.0	Male-all	univariate procedure multiple regression	ANTH (RHR, BF) 1RM BP 1RM SQ PU SU	Ability Test (AT) (all events, timed): Stair Climb 12 steps 8 times Rolled hose (6 ~10 kg) lift & carry 4m to table and back Keiser sled'sledgehammer Hose pull& hydrant hook up Casualty rescue (82 kg,16 m) Charged hose	Climb uphill/stairs Jump up/down/over Push/Pull heavy equipment Move under fire (Run fast < 400m w/without COD) Casualty drag(CD)	Good - Comparison with surrogate task for relevant task	Strong (>0.3 < 0.7)	1RM BP = - 0.44 PU = -0.41	**11.5**
Myhre, Loren	1997	Relationship Between Selected Measures of Physical Fitness and Performance of a Simulated Fire Fighting Emergency Task	USA		Civilian_US_fire/haz/pol	272 male and 7 female career fire fighters from Army and AF bases; full tie 72 hrs/week 24 shifts	279	19-58	Mixed	Pearson product an multiple regression model	(VO2max) Row Bench Press (BP) 80lbBP Curl	Rescue (stairs, run, body drag) (time to rescue)	also 6 and 8 m w load	Good - Comparison with surrogate task for relevant task	Moderate(>0.1 < 0.3)	Age 0.38 (VO2max): -0.33-.36 Row -0.37 Bench Press (BP) - 0.18 80lbBP - 0.17 Curl -0.27	**14**
Pandorf, Clay	2001	Correlates of Load Carriage Performance Among Women	CAN	Lab/Other study	Military_Foreign	soldiers sedenatary amd MP work	12	5.3 + 5.	Female-all	Correlation analyses Stepwise multiple regressions	ANTH and VO2Max AFPT SCORE PU SU 3.2 km	Maximal speed of a 3.2 km paved course w 4 small hills: 14 kg 27 kg	Move >400m <3 mile w load	Strong- Direct task/simulated task comparison	Strong - VeryStrong	14 kg: Anth/VO2; 3.2km (0.80); 27 kg: Anth/VO2; 3.2km (0.61); 41kg: Anth/VO2; 3.2km (0.75);	**16**

Author	Pub Year		Country	Study Type	Population Type	Population Description	Sample Size	Age	Gender	Statistical Analyses Used	Comparison criteria [Physical tests/measurement type(s)]	Performance Task(s) /Simulation Evaluated	Associated Military Common Task(s)	Relevance to US Army Common task (Direct; Indirect- Good; Indirect - Weak; None)	Significant (Single Test-Task) Correlation Strength(s)	STATS FINDINGS	SCORE
Rhea, Matthew	2004	Physical Fitness and Job Performance of Firefighters	USA	Lab/Other study	Civilian_US_fire/haz/pol	professional firefighters: 17 men and 3 women ; tests were done wit hequipmen and tank (no mask)	20	34.5 ± 6.1	Mixed	Pearson correlation coefficients	ANTH/Body Comp 12 min Run **[AER]** 400m sprint **[ANAER]** **[STR]** 5RM BP 5RMSQ Grip (dyn) **[ME]** BP 45 kg SP 11kg Row Grip end	Hose pull Stair climb w22kg hose pk Casualty drag (80kg) Equipment hoist	Push/Pull heavy equipment Lifting carrying equipment/supplies Climb uphill/stairs Casualty drag(CD) Move under fire (Run fast < 400m	Good - Comparison with surrogate task for relevant task	Strong - VeryStrong	Total Test= [**STR**]BP -.66, HG -.71 [ME]:Row -.61, BP, -.73, SP -.71, BC -.69, SQ -.47 [AN]400m 0.79 Hose pull= [STR]BP -.80, HG -.85 SQ 48; [ME]:Row -.63,SP -.75, BC -.67, SQ -.56 [AN]400m 0.67 Stair w22kg = [STR]BP -.39, HG -.46 [ME]:Row -.45, BP, -.52, SP -.54, BC -.55 [AN]400m 0.63 Casualty drag= [STR]BP -.65, HG -.68 [ME]:Row -.58, BP, -.67, SP -.68, BC -.66, [AN]400m 0.81 Equipmt hoist= [STR]BP -.68, HG -.66 [ME]:Row -.52, BP, -.71, SP -.55, BC -.52,	**16**
Robertson, David	1985	Documentation of Muscularly Demanding Job Tasks and Validation of an Occupationsl Strength Battery Test	USA		Military_US_Navy		>300		Mixed	Validity Coeeficients- single and multiple	Arm pull Erometer ILM	various lift and carry	Push/Pull heavy equipment Lifting carrying equipment/supplies	Good - Comparison with surrogate task for relevant task	Strong - VeryStrong	See table 8. Best "single" predictor was arm pull, thoughnone indivuals can predict all - combiningfitness tests increased correlations	**14.5**
Schonfeld, Brian	1990	An Occupational Performance Test Validation Program for Fire Fighters at the Kennedy Space Center	USA		Civilian_US_fire/haz/pol	civilians (NON firefighters sand non smokers) from Kennedy Space Center	20	38.6 ±2.5	Male-all	correlation coef of tasks to fitness measures	(VO2 max) (BF) Treadmill time Peak Torque extension Peal torque flexion	Stair climbing Chopping simulation Victim/Casulaty drag Total	Climb uphill/stairs Push/Pull heavy equipment Lifting carrying equipment/supplies	Good - Comparison with surrogate task for relevant task	Moderate - Strong	Table 4.(VO2 max) - best for stair and total (BF) Treadmill time * victim drag/stair climbing = -0.45 and -0.58 Peak Torque extension - chopping -0.48 Peal torque flexion - stiar (-0.59 and total -0.54)	**15.5**
Singh, Mohan	1991	Task Related Physical Fitness and Performance Standards for the Canadian Army	CAN	Lab/Other study	Military_Foreign	Canadian Forces Base Calgary (Infantry)	116	25.7 (17-44)	Male-all	correlations and multiple regressions	Multiple laborarory tests (isokinetic and dynamic)	Digging slit trench Loaded March Casualty Evac Jerry Can lift/carry	Push/Pull heavy equipment Lifting carrying	Strong- Direct task/simulated task	Moderate(>0.1 < 0.3)		**11**
Sothmann, MS	2004	Performance requirements of physically strenuous occupations:validating minimum standards for muscular strength and	USA	Lab/Other study	Civilian_US_fire/haz/pol	Incumbunt firefighters (138 male, 15 female)	153	36 ± 6	Mixed	ANOVA forward-backward stepwise multiple regression	Hose drag Arm Lift Arm endurance	Firefighter Supression/Evolution Test time Hose drag Dummy drag	Push/Pull heavy equipment Lifting carrying equipment/supplies	Good - Comparison with surrogate task for relevant task	Regression Model	models provide strong correlation indicators of upper body strength and endurance to Firefighter evolution test	[10]
Stevenson, JM	1989	Isoinertial tests to predict lifting performance	CAN		Civilian_Foreign_Other	no muscoskelatal disorder no weightlifting experiencewi ilm	16	22 ± 2	Male-all	Pearson product	ILM max 182 ILM 152 ILM timed (endurance)- TILM	Maximum Box lift Timed blocks lifts	Lifting carrying equipment/supplies	Strong- Direct task/simulated task comparison	Strong - VeryStrong	Maximum Box lift: TILM= .55 ILM183 = .69 ILM152=.71 Timed blocks lifts : TILM= .71 ILM183 = .71 ILM152=.67	**18.5**
Stevenson, Joan	1992	Development of Physical Fitness Standards for Canadian Armed Forces Younger Personnel	CAN		Military_Foreign	< 35 years over a 3 year period from different CF bases	20/task	<35 year	Mixed	Pearson prod	EXPRES test: Step test (sub max) for VO2 Grip (l and r) Push Ups Sit ups	Land Evac (Stretcher Carry)- 1/2 80 kgs, 1- 0.75 km) [Rel= .94] Sea evacuation - fire fighter Ppe, push/carry	Climb uphill/stairs Push/Pull heavy equipment Lifting carrying equipment/supplie	Strong- Direct task/simulated task comparison	Moderate - Strong	Land Evac/Stretcher - MaxGrip: F= -0.34 SU: F= -0.29 Sea evacuation - Max grip F = -0.41 Entrenchment Dig - Max grip F = -0.30 Sandbag carry- VO2max F =0.40 High/low crawl -VO2max F = -0.43 SU F= -0.48 PU F= -0.39 M = -0.42	**14.5**
Thebault, Nicolas	2011	Repeated Sprint Ability and Aerobic Fitness	FRA	Lab/Other study	Military_Foreign	french paratroopers w at least 5 years experience	19	?	Male-all	single and multiple correlations	Squat jump Countermove jump Static knee strength	Shuttle run	Move under fire (Run fast < 400m w/without COD)	Weak/Unclear- Task is generic test for physical capacity	Strong (>0.3 < 0.7)	Squat to Shuttle = 0.46 NOTE: Squat to Countermvmt Jump = 0.99	**12**

Author	Pub Year		Country	Study Type	Population Type	Population Description	Sample Size	Age	Gender	Statistical Analyses Used	Comparison criteria [Physical tests/measurement type(s)]	Performance Task(s) /Simulation Evaluated	Associated Military Common Task(s)	Relevance to US Army Common task (Direct; Indirect-Good; Indirect - Weak; None)	Significant (Single Test-Task) Correlation Strength(s)	STATS FINDINGS	SCORE
Vickers, R	2009	Physical Abilities and Military Task Performance: A Replicaiton and Extension	USA	Lab/Other study	Military_US_Navy	no details provided	88	25.5 + 5.8	Male-all		Treadmil **[AER]** Ergometer **[AN]** **[STR]** Grip (dyn) Arm flex Trunk Flex Leg Ext Trap Lift Bench Press	Test Battery: Dig Slit Trench Casualty Evac (Carry 100m) Jerry Can Carry 21 kg/1.3 m high/35 m 3 trips Ammo Box carry (21 kg) 1.3 m. (truckbed height), 48x	Climb uphill/stairs Jump up/down/over Push/Pull heavy equipment Move under fire (Run fast < 400m w/without COD)	Strong-Direct task/simulated task comparison	Regression Model	"study reinforced doubts about the effectiveness of test-task specificity as a basis for causal inferences about the ability–performance interface. The study also reinforced concerns about omitted variable bias as a problem for performance modeling. The explanation of why GS+AC model works well remains uncertain, but the fact that this model no has proven to be the best option in each of two studies indicates that it is a reliable framework for identifying abilities to target in physical training programs…"	[6]
Vickers, R	2009	Physical Ability-Task Performance Models: Assessing the Risk of Omitted Variable Bias	USA	Lab/Other study	Military_US_Navy	active-duty naval personnel (64 men, 38 women) who passed a screening test: stood upright and pulled on the handles of a small metal box	102 (93)	20-35	Mixed		ILM Curl ILM Press DYN ArmPull DYN Arm Lift BP Leg Press Lat Pull Down Shoulder Press Wingate test	Box lift (elbow height) BoxLift knuckle height Box Carry 34Kg 51 m dist	Lifting equipment/supplies	Strong-Direct task/simulated task comparison	Regression Model	"seven of eight bivariate ability-performance correlations were significant. Despite this diffuse pattern of associations, the final model included only three effects of ability on performance, SS-Lifting, SS-Carrying, and AC-Carrying. The other four significant bivariate associations illustrate the potential for developing biased models."	[9]
Williams-Bell, Michael	2008	Physiological Demands of the Firefighter Candidate Physical Ability Test	CAN	Lab/Other study	Civilian_Foreign_Other	recruits for firefighting	57 (36)	23.7 + 4.6	Mixed	ANOVA Regression coefficients	ANTH VO2Max Bench Press Grip Leg Press Leg Press Endur	Stair Climb Hose Drag Equipment Carry Ladder Raise/Extend Forceable Entry Search (crawl in tunnel 19 m w obstacles) Casualty drag Ceiling Breach and Pull	Climb uphill/stairs Push/Pull heavy equipment Lifting carrying equipment/supplies Scale/crawl overall obstacles/walls Jump up/down/over Casualty drag(CD)	Good - Comparison with surrogate task for relevant task	Strong (>0.3 < 0.7)	BP .42 BP End .47 Grip .47 LP .38 LP endu .20 all are less for men/women separate (Table 30	**9.5**
Williford, Henry	1999	Relationship between fire fighting supression tasks and physical fitness	USA	Lab/Other study	Civilian_US_fire/haz/pol	Montgomery Fire Department; From the 29 units, 13 companies were randomly selected	91	31.7 + 7.4	Male-all	Pearson Correlation	ANTH (H, BF, RHR) PU Pull Ups SU SitNReach 1.5M run Grip Str Comb Dyn	Job Performance assessment (PPA): Stair Climb w 20 Kg hose 70 steps Hoisting 16 kg 5 floor Forceable Entry Hose Advance (pull 30 m) Casulaty Drag	Climb uphill/stairs Push/Pull heavy equipment Lifting carrying equipment/supplies Casualty drag(CD)	Good - Comparison with surrogate task for relevant task	Moderate - Strong	PPA= PU -.38, PushUp-.38, 1.5M -.38, SU -.32, Grip -.54 Stair Climb= PU -.47, PushUp-.47, 1.5M -.56, SU -.32, SR -.25 Grip -.54 Hoisting= PU -.30, PushUp-.35, 1.5M -.30, SU -.22, Grip -.55 ForceEntr= PU -.30, PushUp-.36, 1.5M .25, SU -.22, Grip -.53 Hose Adv= PU -.30, PushUp-.27, Grip -.41 CD = PU -.32, PushUp-.38, 1.5M	**14.5**
Wright, James	1984	Assessment of Muscle Strength and Prediction of Lifting Capacity in US Army Personnel	USA		Military_US_Army	221 males 51 females; assigned to 24th Infantry Div	221	21 + 4	Mixed	Simple correlation	AFPT (2MR, SU, PU) HG Leg ext	Maximal dead lift	Lifting carrying equipment/supplies	Strong-Direct task/simulated task	Weak - Strong	Table 4.	**14.5**

APPENDIX F

Correlation Data
Grouped by Task Categories and Study

Table F-1. Correlation Data Grouped by Task Categories and Study

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure
Casualty Drag	80kg mannequin 30 m	Rhea	2004	J	1	C	20	17	3	AER_d	Trdml run_max D	12 min D on Trdmll	Trdml	2	-0.33	S	min time to max distance
Casualty Drag	82 kg 25.5 m across level grass	Schonfeld	1990	J	2	M	20	20	0	AER_d	Trdml run_max D	distance to fatigue on Trdmll	Trdmll	3	-0.47	S	min time to max distance
Casualty Drag	120 lb (54 kg)Dummy, 50 ft (15 m)	Arvey/a	1992	J	1	U	161	U	U	AER_tr	Distance run-timed	1 M (1.6K)	NA	1	0.35	S	fastest time to fastest time
Casualty Drag	120 lb (54 kg)Dummy, 50 ft (15 m)	Arvey/i	1992	J	1	C	115	96	19	AER_tr	Distance run-timed	1 M (1.6K)	NA	1	0.30	S	min time to min time
Casualty Drag	50m to 80kg(177lb)dummy by web, drag 50m	Harman	2008	J	2	M	32	32	0	AER_tr	Distance run-timed	2 M (3.2K)	NA	1	0.25	N	min time to min time
Casualty Drag	79.5 kg mannequin 30.5 m	Williford	1999	J	2	M	91	91	0	AER_tr	Distance run-timed	1.5M (2.4K)	NA	1	0.23	S	min time to min time
Casualty Drag	82 kg 25.5 m across level grass	Schonfeld	1990	J	2	M	20	20	0	AER_v	Trdml run to eVO2	estimated from Trdmll	Trdmll	3	-0.45	S	min time to max VO2
Casualty Drag	79.5 kg mannequin 30.5 m	Williford	1999	J	2	M	91	91	0	FLX	Sit&Rch		NA	1	-0.06	N	min time to max length
Casualty Drag	80kg mannequin 30 m	Rhea	2004	J	1	C	20	17	3	LB_E	Squat-End	max reps 61 kgs	weights	2	-0.42	N	min time to max #reps
Casualty Drag	80kg mannequin 30 m	Rhea	2004	J	1	C	20	17	3	LB_E_n	Sprint_long	400 m	NA	1	0.81	S	min time to min time
Casualty Drag	120 lb (54 kg)Dummy, 50 ft (15 m)	Arvey/a	1992	J	1	U	161	U	U	LB_E_n	Sprint_short	100 yd	NA	1	0.51	S	min time to min time
Casualty Drag	120 lb (54 kg)Dummy, 50 ft (15 m)	Arvey/i	1992	J	1	C	115	96	19	LB_E_n	Sprint_short	100 yd	NA	1	0.49	S	min time to min time
Casualty Drag	82 kg mannequin drag 15.7m	Michaelides	2011	J	2	M	67	67	0	LB_E_n	Step_ana power	1 min 'anaerobic' power	NA	1	0.04	N	min time to max power
Casualty Drag	50m to 80kg(177lb)dummy by web, drag 50m	Harman	2008	J	2	M	32	32	0	LB_S	Jump-SBJ	Max 3	NA	1	-0.25	N	min time to max length
Casualty Drag	50m to 80kg(177lb)dummy by web, drag 50m	Harman	2008	J	2	M	32	32	0	LB_S	Jump-VJ	Max 3	Vertec meter	1	-0.31	N	min time to max height
Casualty Drag	82 kg mannequin drag 15.7m	Michaelides	2011	J	2	M	67	67	0	LB_S	Jump-VJ	power calc	Vertec meter	3	-0.31	S	min time to max power
Casualty Drag	82 kg mannequin drag 15.7m	Michaelides	2011	J	2	M	67	67	0	LB_S	Squat	1RM	bench	1	-0.21	N	min time to max weight
Casualty Drag	80kg mannequin 30 m	Rhea	2004	J	1	C	20	17	3	LB_S	Squat	5RM	weights	2	-0.30	N	min time to max weight
Casualty Drag	120 lb (54 kg)Dummy, 50 ft (15 m)	Arvey/a	1992	J	1	U	161	U	U	TR_E	SU	1min	NA	1	0.19	S	min time to max #
Casualty Drag	120 lb (54 kg)Dummy, 50 ft (15 m)	Arvey/i	1992	J	1	C	115	96	19	TR_E	SU	1min	NA	1	0.21	S	min time to max #
Casualty Drag	50m to 80kg(177lb)dummy by web, drag 50m	Harman	2008	J	2	M	32	32	0	TR_E	SU	2 min	NA	1	-0.01	N	min time to max #
Casualty Drag	82 kg mannequin drag 15.7m	Michaelides	2011	J	2	M	67	67	0	TR_E	SU	1 min	NA	1	0.01	N	min time to max #
Casualty Drag	79.5 kg mannequin 30.5 m	Williford	1999	J	2	M	91	91	0	TR_E	SU	1 min	NA	1	-0.22	S	min time to max #
Casualty Drag	80kg mannequin 30 m	Rhea	2004	J	1	C	20	17	3	TR_E	SU-AbCurl	Max number reps	weights	2	-0.24	N	min time to max #reps
Casualty Drag	82 kg mannequin drag 15.7m	Michaelides	2011	J	2	M	67	67	0	TR_S	Ab-ISO	3-5 sec best of 3	ABMED	3	-0.29	S	min time to max weight
Casualty Drag	drag 70 kg mannequin 100 m	Singh	1991	TR	3	M	116	116	0	TR_S	TrunkEXT		Electric DYN	3	-0.20	S	min time to max weight
Casualty Drag	drag 70 kg mannequin 100 m	Singh	1991	TR	3	M	116	116	0	TR_S	TrunkFlex		Electric DYN	3	-0.33	S	min time to max weight
Casualty Drag	80kg mannequin 30 m	Rhea	2004	J	1	C	20	17	3	UB_E	ArmCurl-End	14 kg repeats	weights	2	-0.66	S	min time to max #reps
Casualty Drag	120 lb (54 kg)Dummy, 50 ft (15 m)	Arvey/a	1992	J	1	U	161	U	U	UB_E	ArmDip-End	1min	NA(Bench)	2	0.24	S	min time to max # reps
Casualty Drag	120 lb (54 kg)Dummy, 50 ft (15 m)	Arvey/i	1992	J	1	C	115	96	19	UB_E	ArmDip-End	1min	NA(Bench)	2	0.18	N	min time to max # reps
Casualty Drag	80kg mannequin 30 m	Rhea	2004	J	1	C	20	17	3	UB_E	ArmRow-End	20.5 kg dumbells	weights	2	-0.58	S	min time to max #reps
Casualty Drag	80kg mannequin 30 m	Rhea	2004	J	1	C	20	17	3	UB_E	BenchPress-End	Max # reps 45kg	weights	2	-0.67	S	min time to max #reps
Casualty Drag	80kg mannequin 30 m	Rhea	2004	J	1	C	20	17	3	UB_E	GRIP-End	25kg force - hold	Dyn	2	-0.10	N	min time to max time
Casualty Drag	79.5 kg mannequin 30.5 m	Williford	1999	J	2	M	91	91	0	UB_E	PullUp	max #/no time limit		2	-0.32	S	min time to max #
Casualty Drag	50m to 80kg(177lb)dummy by web, drag 50m	Harman	2008	J	2	M	32	32	0	UB_E	PushUp	2 min	NA	1	0.16	N	min time to max #
Casualty Drag	82 kg mannequin drag 15.7m	Michaelides	2011	J	2	M	67	67	0	UB_E	PushUp	max #/no time limit		1	0.08	N	min time to max #
Casualty Drag	79.5 kg mannequin 30.5 m	Williford	1999	J	2	M	91	91	0	UB_E	PushUp	max #/no time limit		1	-0.38	S	min time to max #
Casualty Drag	80kg mannequin 30 m	Rhea	2004	J	1	C	20	17	3	UB_E	ShldrPr-End	11 kg	weights	2	-0.68	S	min time to max #reps
Casualty Drag	drag 70 kg mannequin 100 m	Singh	1991	TR	3	M	116	116	0	UB_S	ArmFlex		iso	2	-0.11	N	min time to max weight
Casualty Drag	82 kg mannequin drag 15.7m	Michaelides	2011	J	2	M	67	67	0	UB_S	BenchPress	IRM best of 3	weights	2	-0.31	S	min time to max weight
Casualty Drag	80kg mannequin 30 m	Rhea	2004	J	1	C	20	17	3	UB_S	BenchPress	5RM	weights	2	-0.65	S	min time to max weight
Casualty Drag	120 lb (54 kg)Dummy, 50 ft (15 m)	Arvey/a	1992	J	1	U	161	U	U	UB_S	GRIP-Str	Dominant hand	DYN-H	2	0.43	S	min time to max weight
Casualty Drag	120 lb (54 kg)Dummy, 50 ft (15 m)	Arvey/i	1992	J	1	C	115	96	19	UB_S	GRIP-Str	Dominant hand	DYN-H	2	0.35	S	min time to max weight
Casualty Drag	82 kg mannequin drag 15.7m	Michaelides	2011	J	2	M	67	67	0	UB_S	GRIP-Str	C - sum left and right	Grip-Dyn	2	-0.41	S	min time to max weight
Casualty Drag	80kg mannequin 30 m	Rhea	2004	J	1	C	20	17	3	UB_S	GRIP-Str	no details	Dyn	2	-0.68	S	min time to max force
Casualty Drag	drag 70 kg mannequin 100 m	Singh	1991	TR	3	M	116	116	0	UB_S	GRIP-Str	Avg R & L		2	-0.05	N	min time to max weight
Casualty Drag	79.5 kg mannequin 30.5 m	Williford	1999	J	2	M	91	91	0	UB_S	GRIP-Str	C - avg R&L	Grip-Dyn	2	-0.59	S	min time to max weight
Casualty Drag	82 kg 25.5 m across level grass	Schonfeld	1990	J	2	M	20	20	0	WB_S	ArmLegPkEXTDYN	avg of R&L arm& leg	Cybex	3	-0.20	N	min time to max weight
Casualty Drag	82 kg 25.5 m across level grass	Schonfeld	1990	J	2	M	20	20	0	WB_S	ArmLegPkFlexDYN	avg of R&L arm& leg	Cybex	3	-0.28	N	min time to max weight

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure
Climb	up and down 5 flights of stairs w 22kg pack	Rhea	2004	J	1	C	20	17	3	AER_d	Trdml run_max D	12 min D on Trdmll	Trdml	2	-0.36	N	min time to max distance
Climb	7 flights x 15 stairs up/down in 32kg SCBA gear	Schonfeld	1990	J	2	M	20	20	0	AER_d	Trdml run_max D	distance to fatigue on Trdmll	Trdmll	3	-0.58	S	min time to max distance
Climb	up 70 step tower carrying 22 kg hose	Williford	1999	J	2	M	91	91	0	AER_tr	Distance run-timed	1.5M (2.4K)	NA	1	0.56	S	min time to min time
Climb	7 flights x 15 stairs up/down in 32kg SCBA gear	Schonfeld	1990	J	2	M	20	20	0	AER_v	Trdml run to eVO2	estimated from Trdmll	Trdmll	3	-0.63	S	min time to max VO2
Climb	up 70 step tower carrying 22 kg hose	Williford	1999	J	2	M	91	91	0	FLX	Sit&Rch		NA	1	-0.25	S	min time to max length
Climb	up and down 5 flights of stairs w 22kg pack	Rhea	2004	J	1	C	20	17	3	LB_E	Squat-End	max reps 61 kgs	weights	2	-0.39	N	min time to max #reps
Climb	up and down 5 flights of stairs w 22kg pack	Rhea	2004	J	1	C	20	17	3	LB_E_n	Sprint_long	400 m	NA	1	0.63	S	min time to min time
Climb	climb and descend 12 stairs x 8	Michaelides	2011	J	2	M	67	67	0	LB_E_n	Step_ana power	1 min 'anaerobic' power	NA	1	-0.39	S	min time to max power
Climb	climb and descend 12 stairs x 8	Michaelides	2011	J	2	M	67	67	0	LB_S	Jump-VJ	power calc	Vertec meter	3	0.24	N	min time to max power
Climb	climb and descend 12 stairs x 8	Michaelides	2011	J	2	M	67	67	0	LB_S	Squat	1RM	bench	1	-0.02	N	min time to max weight
Climb	up and down 5 flights of stairs w 22kg pack	Rhea	2004	J	1	C	20	17	3	LB_S	Squat	5RM	weights	2	-0.11	N	min time to max weight
Climb	climb and descend 12 stairs x 8	Michaelides	2011	J	2	M	67	67	0	TR_E	SU	1 min	NA	1	-0.50	S	min time to max #
Climb	up 70 step tower carrying 22 kg hose	Williford	1999	J	2	M	91	91	0	TR_E	SU	1 min		1	-0.41	S	min time to max #
Climb	up and down 5 flights of stairs w 22kg pack	Rhea	2004	J	1	C	20	17	3	TR_E	SU-AbCurl	Max number reps	weights	2	-0.21	N	min time to max #reps
Climb	climb and descend 12 stairs x 8	Michaelides	2011	J	2	M	67	67	0	TR_S	Ab-ISO	3-5 sec best of 3	ABMED	2	-0.38	S	min time to max weight
Climb	up and down 5 flights of stairs w 22kg pack	Rhea	2004	J	1	C	20	17	3	UB_E	ArmCurl-End	14 kg repeats	weights	2	-0.55	S	min time to max #reps
Climb	up and down 5 flights of stairs w 22kg pack	Rhea	2004	J	1	C	20	17	3	UB_E	ArmRow-End	20.5 kg dumbells	weights	2	-0.45	S	min time to max #reps
Climb	up and down 5 flights of stairs w 22kg pack	Rhea	2004	J	1	C	20	17	3	UB_E	BenchPress-End	Max # reps 45kg	weights	2	-0.52	S	min time to max #reps
Climb	up and down 5 flights of stairs w 22kg pack	Rhea	2004	J	1	C	20	17	3	UB_E	GRIP-End	25kg force - hold	Dyn	2	-0.36	N	min time to max time
Climb	up 70 step tower carrying 22 kg hose	Williford	1999	J	2	M	91	91	0	UB_E	PullUp	max #/no time limit		1	-0.47	S	min time to max #
Climb	climb and descend 12 stairs x 8	Michaelides	2011	J	2	M	67	67	0	UB_E	PushUp	max #/no time limit		1	-0.39	S	min time to max #
Climb	up 70 step tower carrying 22 kg hose	Williford	1999	J	2	M	91	91	0	UB_E	PushUp	max #/no time limit		1	-0.47	S	min time to max #
Climb	up and down 5 flights of stairs w 22kg pack	Rhea	2004	J	1	C	20	17	3	UB_E	ShldrPr-End	11 kg	weights	2	-0.54	S	min time to max #reps
Climb	climb and descend 12 stairs x 8	Michaelides	2011	J	2	M	67	67	0	UB_S	BenchPress	IRM best of 3	Bench	2	-0.10	N	min time to max weight
Climb	up and down 5 flights of stairs w 22kg pack	Rhea	2004	J	1	C	20	17	3	UB_S	BenchPress	5RM	weights	2	-0.39	S	min time to max weight
Climb	climb and descend 12 stairs x 8	Michaelides	2011	J	2	M	67	67	0	UB_S	GRIP-Str	C - sum left and right	Grip-Dyn	2	0.16	N	min time to max weight
Climb	up and down 5 flights of stairs w 22kg pack	Rhea	2004	J	1	C	20	17	3	UB_S	GRIP-Str	no details	Dyn	2	-0.46	S	min time to max force
Climb	up 70 step tower carrying 22 kg hose	Williford	1999	J	2	M	91	91	0	UB_S	GRIP-Str	C - avg R&L	Grip-Dyn	2	-0.39	S	min time to max weight
Climb	7 flights x 15 stairs up/down in 32kg SCBA gear	Schonfeld	1990	J	2	M	20	20	0	WB_S	ArmLegPkEXTDYN	avg of R&L arm& leg	Cybex	3	-0.31	N	min time to max weight
Climb	7 flights x 15 stairs up/down in 32kg SCBA gear	Schonfeld	1990	J	2	M	20	20	0	WB_S	ArmLegPkFlexDYN	avg of R&L arm& leg	Cybex	3	-0.59	S	min time to max weight

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure	best to best
Crawl (High/Low)	TIME 30m Low 45m High	Deakin	2000	TR	2	C	623	416	207	AER_v	Shuttle_eV02	MaxSpd-mltstg20m repeat	CalcVO2Mx	3	-0.83	S	min time to max VO2	min-max
Crawl (High/Low)	TIME 30m Low 45m High	Deakin	2000	TR	2	C	623	416	207	AER_v	Step_eVO2	estimated from HR/Oxg cons	CalcVO2Mx	3	-0.76	S	min time to max VO2	min-max
Crawl (High/Low)	TIME 30m Low 45m High	Deakin	2000	TR	2	C	623	416	207	LB_S	Jump-VJ	Max 3	NA	1	-0.75	S	min time to max height	min-max
Crawl (High/Low)	TIME 30m Low 45m High	Deakin	2000	TR	2	C	623	416	207	LB_S	LegEXT	Max 3	DYN	1	-0.53	S	min time to max weight	min-max
Crawl (High/Low)	TIME 30m Low 45m High	Deakin	2000	TR	2	C	623	416	207	TR_E	SU	1 min	NA	1	-0.62	S	min time to max #	min-max
Crawl (High/Low)	14 kg load on crawl wood and wire obstacle	Pandorf/Frykman	2001	J	1	F	12	0	12	TR_E	SU	2 min	NA	1	-0.60	S	min time to max #	min-max
Crawl (High/Low)	27 kg load on crawl wood and wire obstacle	Pandorf/Frykman	2001	J	1	F	12	0	12	TR_E	SU	2 min	NA	1	-0.55	S	min time to max #	min-max
Crawl (High/Low)	Low 30m and high 45m w rifle and helmet	Stevenson	1992	J	2	F	33	0	33	TR_E	SU	1 min		1	-0.48	S	min time to max #	min-max
Crawl (High/Low)	Low 30m and high 45m w rifle and helmet	Stevenson	1992	J	2	M	99	99	0	TR_E	SU	1 min		1	-0.18	N	min time to max #	min-max
Crawl (High/Low)	TIME 30m Low 45m High	Deakin	2000	TR	2	C	623	416	207	TR_S	BackExt-DYN	Max 3	DYN	3	-0.64	S	min time to max weight	min-max
Crawl (High/Low)	TIME 30m Low 45m High	Deakin	2000	TR	2	C	623	416	207	UB_E	PullUp	Max	NA (Bar)	1	-0.79	S	min time to max #	min-max
Crawl (High/Low)	TIME 30m Low 45m High	Deakin	2000	TR	2	C	623	416	207	UB_E	PushUp	Max	NA	1	-0.80	S	min time to max #	min-max
Crawl (High/Low)	14 kg load on crawl wood and wire obstacle	Pandorf/Frykman	2001	J	1	F	12	0	12	UB_E	PushUp	2 min	NA	1	-0.59	S	min time to max #	min-max
Crawl (High/Low)	Low 30m and high 45m w rifle and helmet	Stevenson	1992	J	2	F	33	0	33	UB_E	PushUp	1 min		1	-0.39	S	min time to max #	min-max
Crawl (High/Low)	Low 30m and high 45m w rifle and helmet	Stevenson	1992	J	2	M	99	99	0	UB_E	PushUp	1 min		1	-0.42	S	min time to max #	min-max
Crawl (High/Low)	TIME 30m Low 45m High	Deakin	2000	TR	2	C	623	416	207	UB_S	Arm Pull	Max 3	UBSD	3	-0.59	S	min time to max height (wt)	min-max
Crawl (High/Low)	TIME 30m Low 45m High	Deakin	2000	TR	2	C	623	416	207	UB_S	ArmPush	Max 3	UBSD	3	-0.59	S	min time to max height (wt)	min-max
Crawl (High/Low)	TIME 30m Low 45m High	Deakin	2000	TR	2	C	623	416	207	UB_S	GRIP-Str	C-Sum 3	DYN	3	-0.60	S	min time to max strength	min-max
Crawl (High/Low)	Low 30m and high 45m w rifle and helmet	Stevenson	1992	J	2	F	33	0	33	UB_S	GRIP-Str	Max L&R	Grip-Dyn	2	-0.13	N	min time to max weight	min-max
Crawl (High/Low)	Low 30m and high 45m w rifle and helmet	Stevenson	1992	J	2	M	99	99	0	UB_S	GRIP-Str	Max L&R	Grip-Dyn	2	-0.17	N	min time to max weight	min-max
Crawl (High/Low)	27 kg load on crawl wood and wire obstacle	Pandorf/Frykman	2001	J	1	F	12	0	12	WB_S/E/A	APFT	2MR/SU/PU	NA	1	-0.67	S	min time to max score	min-max
Dig	TIME trench/foxhole dig 1.8 mx .6x.45m	Deakin	2000	TR	2	C	623	416	207	AER_v	Shuttle_eV02	MaxSpd-mltstg20m repeat	CalcVO2Mx	3	-0.67	S	min time to max VO2	min-max
Dig	TIME trench/foxhole dig 1.8 mx .6x.45m	Deakin	2000	TR	2	C	623	416	207	AER_v	Step_eVO2	estimated from HR/Oxg cons	CalcVO2Mx	3	-0.57	S	min time to max VO2	min-max
Dig	overhead swing: kg slegdehammer to 1.5m	Michaelides	2011	J	2	M	67	67	0	LB_E_n	Step_ana power	1 min 'anaerobic' power	NA	1	-0.15	N	min time to max power	min-max
Dig	TIME trench/foxhole dig 1.8 mx .6x.45m	Deakin	2000	TR	2	C	623	416	207	LB_S	Jump-VJ	Max 3	NA	1	-0.65	S	min time to max height	min-max
Dig	overhead swing: kg slegdehammer to 1.5m	Michaelides	2011	J	2	M	67	67	0	LB_S	Jump-VJ	power calc	Vertec meter	3	-0.22	N	min time to max power	min-max
Dig	TIME trench/foxhole dig 1.8 mx .6x.45m	Deakin	2000	TR	2	C	623	416	207	LB_S	LegEXT	Max 3	DYN	3	-0.56	S	min time to max weight	min-max
Dig	TIME trench/foxhole dig 1.8 mx .6x.45m	Deakin	2000	TR	2	C	623	416	207	TR_E	SU	2 min	NA	1	-0.42	S	min time to max #	min-max
Dig	overhead swing: kg slegdehammer to 1.5m	Michaelides	2011	J	2	M	67	67	0	TR_E	SU	1 min	NA	1	-0.08	N	min time to max #	min-max
Dig	trench dig - 1.82m .61w .46 d	Stevenson	1992	J	2	F	33	0	33	TR_E	SU	1 min		1	-0.25	N	min time to max #	min-max
Dig	trench dig - 1.82m .61w .46 d	Stevenson	1992	J	2	M	99	99	0	TR_E	SU	1 min		1	-0.04	N	min time to max #	min-max
Dig	overhead swing: kg slegdehammer to 1.5m	Michaelides	2011	J	2	M	67	67	0	TR_S	Ab-ISO	3-5 sec best of 3	ABMED	3	-0.35	S	min time to max weight	min-max
Dig	TIME trench/foxhole dig 1.8 mx .6x.45m	Deakin	2000	TR	2	C	623	416	207	TR_S	BackExt-DYN	Max 3	DYN	3	-0.66	S	min time to max weight	min-max
Dig	simulated foxhole trench dig	Singh	1991	TR	3	M	116	116	0	TR_S	TrunkEXT		Electric DYN	3	-0.47	S	min time to max weight	min-max
Dig	simulated foxhole trench dig	Singh	1991	TR	3	M	116	116	0	TR_S	TrunkFlex		Electric DYN	3	-0.30	S	min time to max weight	min-max
Dig	TIME trench/foxhole dig 1.8 mx .6x.45m	Deakin	2000	TR	2	C	623	416	207	UB_E	PullUp	Max	NA (Bar)	1	-0.63	S	min time to max #	min-max
Dig	TIME trench/foxhole dig 1.8 mx .6x.45m	Deakin	2000	TR	2	C	623	416	207	UB_E	PushUp	Max	NA	1	-0.66	S	min time to max #	min-max
Dig	overhead swing: kg slegdehammer to 1.5m	Michaelides	2011	J	2	M	67	67	0	UB_E	PushUp	max #/no time limit	NA	1	-0.06	N	min time to max #	min-max
Dig	trench dig - 1.82m .61w .46 d	Stevenson	1992	J	2	F	33	0	33	UB_E	PushUp	1 min	NA	1	-0.27	N	min time to max #	min-max
Dig	trench dig - 1.82m .61w .46 d	Stevenson	1992	J	2	M	99	99	0	UB_E	PushUp	1 min	NA	1	-0.02	N	min time to max #	min-max
Dig	TIME trench/foxhole dig 1.8 mx .6x.45m	Deakin	2000	TR	2	C	623	416	207	UB_S	Arm Pull	Max weight 3	UBSD	3	-0.65	S	min time to max height (wt)	min-max
Dig	simulated foxhole trench dig	Singh	1991	TR	3	M	116	116	0	UB_S	ArmFlex		iso	2	-0.22	S	min time to max weight	min-max
Dig	TIME trench/foxhole dig 1.8 mx .6x.45m	Deakin	2000	TR	2	C	623	416	207	UB_S	ArmPush	Max 3	UBSD	3	-0.61	S	min time to max height (wt)	min-max
Dig	overhead swing: kg slegdehammer to 1.5m	Michaelides	2011	J	2	M	67	67	0	UB_S	BenchPress	IRM best of 3	Bench	2	-0.41	S	min time to max weight	min-max
Dig	TIME trench/foxhole dig 1.8 mx .6x.45m	Deakin	2000	TR	2	C	623	416	207	UB_S	GRIP-Str	C-Sum 3	DYN	2	-0.67	S	min time to max strength	min-max
Dig	overhead swing: kg slegdehammer to 1.5m	Michaelides	2011	J	2	M	67	67	0	UB_S	GRIP-Str	C - sum left and right	Grip-Dyn	2	-0.30	S	min time to max weight	min-max
Dig	simulated foxhole trench dig	Singh	1991	TR	3	M	116	116	0	UB_S	GRIP-Str	Avg R & L		2	-0.18	S	min time to max weight	min-max
Dig	trench dig - 1.82m .61w .46 d	Stevenson	1992	J	2	F	33	0	33	UB_S	GRIP-Str	Max L&R	Grip-Dyn	2	-0.30	S	min time to max weight	min-max
Dig	trench dig - 1.82m .61w .46 d	Stevenson	1992	J	2	M	99	99	0	UB_S	GRIP-Str	Max L&R	Grip-Dyn	2	-0.32	N	min time to max weight	min-max

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure
Lift & Carry	16 kg hose coil up 5 flights	Rhea	2004	J	1	C	20	17	3	AER_d	Trdml run_max D	12 min D on Trdmll	Trdml	2	-0.12	N	min time to max distance
Lift & Carry	Task=lift 31 kg - D=51 m	Beckett	1988	TR	2	C	102	64	38	AER_tr	Distance run-timed	1.5M (2.4K)	NA	1	-0.67	S	max weight to min time
Lift & Carry	sandbag 20 kg 50 m	Deakin	2000	TR	2	C	623	416	207	AER_v	Shuttle_eV02	MaxSpd-mltstg20m repeat	CalcVO2Mx	3	0.89	S	max # bags to max VO2
Lift & Carry	sandbag 20 kg 50 m	Deakin	2000	TR	2	C	623	416	207	AER_v	Step_eVO2	estimated from HR/Oxg cons	CalcVO2Mx	3	0.76	S	max # bags to max VO2
Lift & Carry	Task=lift 31 kg - D=51 m	Beckett	1988	TR	2	C	102	64	38	FLX	Sit&Rch	1sec, last of 3	NA	1	0.01	N	max weight to max reach
Lift & Carry	16 kg hose coil up 5 flights	Rhea	2004	J	1	C	20	17	3	LB_E	Squat-End	max reps 61 kgs	weights	2	-0.35	N	min time to max #reps
Lift & Carry	16 kg hose coil up 5 flights	Rhea	2004	J	1	C	20	17	3	LB_E_n	Sprint_long	400 m	NA	1	0.59	S	min time to min time
Lift & Carry	Task=lift 31 kg - D=51 m	Beckett	1988	TR	2	C	102	64	38	LB_E_n	Sprint_short	100 m	NA	1	-0.54	S	max weight to min time
Lift & Carry	lift& carry six 10 kg hoseroll 16 m	Michaelides	2011	J	2	M	67	67	0	LB_E_n	Step_ana power	1 min 'anaerobic' power	NA	1	-0.34	S	min time to max power
Lift & Carry	Task=lift 31 kg - D=51 m	Beckett	1988	TR	2	C	102	64	38	LB_S	Jump-SBJ	best of 3	NA	1	0.45	S	max weight to max height
Lift & Carry	Task=lift 31 kg - D=51 m	Beckett	1988	TR	2	C	102	64	38	LB_S	Jump-VJ	Max 2	Vertec dvc	3	0.39	S	max weight to max height
Lift & Carry	sandbag 20 kg 50 m	Deakin	2000	TR	2	C	623	416	207	LB_S	Jump-VJ	Max 3	NA	1	0.73	S	max # bags to max height
Lift & Carry	lift& carry six 10 kg hoseroll 16 m	Michaelides	2011	J	2	M	67	67	0	LB_S	Jump-VJ	power calc	Vertec meter	3	-0.02	N	min time to max power
Lift & Carry	sandbag 20 kg 50 m	Deakin	2000	TR	2	C	623	416	207	LB_S	LegEXT	Max 3	DYN	3	0.48	S	max # bags to max weight
Lift & Carry	lift& carry six 10 kg hoseroll 16 m	Michaelides	2011	J	2	M	67	67	0	LB_S	Squat	1RM	bench	1	-0.24	N	min time to max weight
Lift & Carry	16 kg hose coil up 5 flights	Rhea	2004	J	1	C	20	17	3	LB_S	Squat	5RM	weights	2	-0.34	N	min time to max weight
Lift & Carry	Task=lift 31 kg - D=51 m	Beckett	1988	TR	2	C	102	64	38	TR_E	SU	2 min	NA	1	0.31	S	max weight to max #
Lift & Carry	sandbag 20 kg 50 m	Deakin	2000	TR	2	C	623	416	207	TR_E	SU	2 min	NA	1	0.63	S	max # bags to max #
Lift & Carry	lift& carry six 10 kg hoseroll 16 m	Michaelides	2011	J	2	M	67	67	0	TR_E	SU	1 min	NA	1	-0.52	S	min time to max #
Lift & Carry	carry pump 147lb/2 people up/down/150 ft: Work Outp	Robertson	1985	TR	2	C	45	24	21	TR_E	SU	1 min	NA	1	0.12	N	max work output to max #rep
Lift & Carry	carry 43lb hose up 2 flight stairs &75 ft: Work Output	Robertson	1985	TR	2	C	45	24	21	TR_E	SU	1 min	NA	1	-0.05	N	max work output to max #rep
Lift & Carry	8 x 22.7 kg sand bag carry 50m in 10 min	Stevenson	1992	J	2	F	33	0	33	TR_E	SU	1 min	NA	1	0.44	N	min time to max #
Lift & Carry	8 x 22.7 kg sand bag carry 50m in 10 min	Stevenson	1992	J	2	M	99	99	0	TR_E	SU	1 min	NA	1	0.32	N	min time to max #
Lift & Carry	16 kg hose coil up 5 flights	Rhea	2004	J	1	C	20	17	3	TR_E	SU-AbCurl	Max number reps	weights	2	-0.11	N	min time to max #reps
Lift & Carry	lift& carry six 10 kg hoseroll 16 m	Michaelides	2011	J	2	M	67	67	0	TR_S	Ab-ISO	3-5 sec best of 3	ABMED	3	-0.49	S	min time to max weight
Lift & Carry	sandbag 20 kg 50 m	Deakin	2000	TR	2	C	623	416	207	TR_S	BackExt-DYN	Max 3	DYN	3	0.59	S	max # bags to max weight
Lift & Carry	two 21 kg jerry can carry 35m x 3 shuttle	Singh	1991	TR	3	M	116	116	0	TR_S	TrunkEXT		Electric DYN	3	-0.26	S	min time to max weight
Lift & Carry	two 21 kg jerry can carry 35m x 3 shuttle	Singh	1991	TR	3	M	116	116	0	TR_S	TrunkFlex		Electric DYN	3	-0.24	S	min time to max weight
Lift & Carry	Task=lift 31 kg - D=51 m	Beckett	1988	TR	2	C	102	64	38	UB_E	ArmCurl-End	ENDHoldCurl	ILM	2	-0.04	N	max weight to max time
Lift & Carry	16 kg hose coil up 5 flights	Rhea	2004	J	1	C	20	17	3	UB_E	ArmCurl-End	14 kg repeats	weights	2	-0.52	S	min time to max #reps
Lift & Carry	16 kg hose coil up 5 flights	Rhea	2004	J	1	C	20	17	3	UB_E	ArmRow-End	20.5 kg dumbells	weights	2	-0.52	S	min time to max #reps
Lift & Carry	16 kg hose coil up 5 flights	Rhea	2004	J	1	C	20	17	3	UB_E	BenchPress-End	Max # reps 45kg	weights	2	-0.71	S	min time to max #reps
Lift & Carry	16 kg hose coil up 5 flights	Rhea	2004	J	1	C	20	17	3	UB_E	GRIP-End	25kg force - hold	Dyn	3	-0.17	N	min time to max time
Lift & Carry	Task=lift 31 kg - D=51 m	Beckett	1988	TR	2	C	102	64	38	UB_E	PullUp	max #/no time limit	NA (Bar)	1	0.55	S	max weight to max #
Lift & Carry	sandbag 20 kg 50 m	Deakin	2000	TR	2	C	623	416	207	UB_E	PullUp	Max	NA (Bar)	1	0.74	S	max # bags to max #
Lift & Carry	Task=lift 31 kg - D=51 m	Beckett	1988	TR	2	C	102	64	38	UB_E	PushUp	2 min	NA	1	0.56	S	max weight to max #
Lift & Carry	sandbag 20 kg 50 m	Deakin	2000	TR	2	C	623	416	207	UB_E	PushUp	Max	NA	1	0.75	S	max # bags to max #
Lift & Carry	lift& carry six 10 kg hoseroll 16 m	Michaelides	2011	J	2	M	67	67	0	UB_E	PushUp	max #/no time limit	NA	1	-0.30	S	min time to max #
Lift & Carry	carry pump 147lb/2 people up/down/150 ft: Work Outp	Robertson	1985	TR	2	C	45	24	21	UB_E	PushUp	no details	NA	1	0.48	S	max work output to max #rep
Lift & Carry	carry 43lb hose up 2 flight stairs &75 ft: Work Output	Robertson	1985	TR	2	C	45	24	21	UB_E	PushUp	no details	NA	1	0.39	S	max work output to max #rep
Lift & Carry	8 x 22.7 kg sand bag carry 50m in 10 min	Stevenson	1992	J	2	F	33	0	33	UB_E	PushUp	1 min	NA	1	0.32	N	min time to max #
Lift & Carry	8 x 22.7 kg sand bag carry 50m in 10 min	Stevenson	1992	J	2	M	99	99	0	UB_E	PushUp	1 min	NA	1	0.27	N	min time to max #

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure
Lift & Carry	16 kg hose coil up 5 flights	Rhea	2004	J	1	C	20	17	3	**UB_E**	**ShldrPr-End**	11 kg	weights	2	**-0.55**	S	min time to max #reps
Lift & Carry	carry pump 147lb/2 people up/down/150 ft: Work Outp	Robertson	1985	TR	2	C	45	24	21	**UB_E_n**	**Ergom**	#rev at 30sec 600kpm	Erg/RehbTrnr	3	**0.64**	S	max work output to max #rep
Lift & Carry	carry 43lb hose up 2 flight stairs &75 ft: Work Output	Robertson	1985	TR	2	C	45	24	21	**UB_E_n**	**Ergom**	#rev at 30sec 600kpm	Erg/RehbTrnr	3	**0.51**	S	max work output to max #rep
Lift & Carry	carry pump 147lb/2 people up/down/150 ft: Work Outp	Robertson	1985	TR	2	C	45	24	21	**UB_S**	**Arm Lift**	avg of 3 gauge pull(lift) from elbo	Chatillon g	2	**0.45**	S	max work output to max weight
Lift & Carry	carry 43lb hose up 2 flight stairs &75 ft: Work Output	Robertson	1985	TR	2	C	45	24	21	**UB_S**	**Arm Lift**	avg of 3 gauge pull(lift) from elbo	Chatillon g	2	**0.57**	S	max work output to max weight
Lift & Carry	sandbag 20 kg 50 m	Deakin	2000	TR	2	C	623	416	207	**UB_S**	**Arm Pull**	Max 3	UBSD	3	**0.53**	S	max # bags to max height (wt)
Lift & Carry	carry pump 147lb/2 people up/down/150 ft: Work Outp	Robertson	1985	TR	2	C	45	24	21	**UB_S**	**Arm Pull**	1 hand ea pull gauge max avg of 3	Chatillon g	2	**0.66**	S	max work output to max weight
Lift & Carry	carry 43lb hose up 2 flight stairs &75 ft: Work Output	Robertson	1985	TR	2	C	45	24	21	**UB_S**	**Arm Pull**	1 hand ea pull gauge max avg of 3	Chatillon g	2	**0.57**	S	max work output to max weight
Lift & Carry	Task=lift 31 kg - D=51 m	Beckett	1988	TR	2	C	102	64	38	**UB_S**	**ArmCurl**	MxWt to Elb	ILM	3	**0.49**	S	max weight to max weight
Lift & Carry	two 21 kg jerry can carry 35m x 3 shuttle	Singh	1991	TR	3	M	116	116	0	**UB_S**	**ArmFlex**		iso	3	**-0.07**	N	min time to max weight
Lift & Carry	sandbag 20 kg 50 m	Deakin	2000	TR	2	C	623	416	207	**UB_S**	**ArmPush**	Max 3	UBSD	3	**0.53**	S	max # bags to max height (wt)
Lift & Carry	Task=lift 31 kg - D=51 m	Beckett	1988	TR	2	C	102	64	38	**UB_S**	**BenchPress**	MaxWt 152cm	ILM	3	**0.50**	S	max weight to max weight
Lift & Carry	lift& carry six 10 kg hoseroll 16 m	Michaelides	2011	J	2	M	67	67	0	**UB_S**	**BenchPress**	IRM best of 3	Bench	2	**-0.30**	S	min time to max weight
Lift & Carry	16 kg hose coil up 5 flights	Rhea	2004	J	1	C	20	17	3	**UB_S**	**BenchPress**	5RM	weights	2	**-0.68**	S	min time to max weight
Lift & Carry	sandbag 20 kg 50 m	Deakin	2000	TR	2	C	623	416	207	**UB_S**	**GRIP-Str**	C-Sum 3	DYN	2	**0.56**	S	max # bags to max strength
Lift & Carry	lift& carry six 10 kg hoseroll 16 m	Michaelides	2011	J	2	M	67	67	0	**UB_S**	**GRIP-Str**	C - sum left and right	Grip-Dyn	2	**0.00**	N	min time to max weight
Lift & Carry	16 kg hose coil up 5 flights	Rhea	2004	J	1	C	20	17	3	**UB_S**	**GRIP-Str**	no details	Dyn	2	**-0.66**	S	min time to max force
Lift & Carry	carry pump 147lb/2 people up/down/150 ft: Work Outp	Robertson	1985	TR	2	C	45	24	21	**UB_S**	**GRIP-Str**	no details	DYN	2	**0.51**	S	max work output to max weight
Lift & Carry	carry 43lb hose up 2 flight stairs &75 ft: Work Output	Robertson	1985	TR	2	C	45	24	21	**UB_S**	**GRIP-Str**	no details	DYN	2	**0.62**	S	max work output to max weight
Lift & Carry	two 21 kg jerry can carry 35m x 3 shuttle	Singh	1991	TR	3	M	116	116	0	**UB_S**	**GRIP-Str**	Avg R & L		2	**-0.25**	S	min time to max weight
Lift & Carry	8 x 22.7 kg sand bag carry 50m in 10 min	Stevenson	1992	J	2	F	33	0	33	**UB_S**	**GRIP-Str**	Max L&R	Grip-Dyn	2	**0.26**	N	min time to max weight
Lift & Carry	8 x 22.7 kg sand bag carry 50m in 10 min	Stevenson	1992	J	2	M	99	99	0	**UB_S**	**GRIP-Str**	Max L&R	Grip-Dyn	2	**0.10**	N	min time to max weight

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure
Lift & Lower (R)	repeatbox lift: 20.45kg metal bx 1.32mH 10 min	Kraemer	1998	J	3	F	123	0	123	AER_tr	Distance run-timed	2 M (3.2K)	NA	1	-0.54	S	max # reps to min time
Lift & Lower (R)	LC25/10	Wright	1984	TR	2	C	272	221	51	AER_tr	Distance run-timed	2 M (3.2K)	NA	1	-0.49	S	max carries to min time
Lift & Lower (R)	LC43/10	Wright	1984	TR	2	C	272	221	51	AER_tr	Distance run-timed	2 M (3.2K)	NA	1	-0.51	S	max carries to min time
Lift & Lower (R)	jerrycan 20 kg repeat -10 min	Deakin	2000	TR	2	C	623	416	207	AER_v	Shuttle_eV02	MaxSpd-mltstg20m repeat	CalcVO2Mx	3	0.75	S	max # cans to max VO2
Lift & Lower (R)	jerrycan 20 kg repeat -10 min	Deakin	2000	TR	2	C	623	416	207	AER_v	Step_eVO2	estimated from HR/Oxg cons	CalcVO2Mx	3	0.65	S	max # cans to max VO2
Lift & Lower (R)	repeatbox lift: 20.45kg metal bx 1.32mH 10 min	Kraemer	1998	J	3	F	123	0	123	LB_E	Squat-End	45kg lift .36m repeats	weights	2	0.55	S	max # reps to max #reps
Lift & Lower (R)	jerrycan 20 kg repeat -10 min	Deakin	2000	TR	2	C	623	416	207	LB_S	Jump-VJ	Max 3	NA	1	0.79	S	max # cans to max height
Lift & Lower (R)	jerrycan 20 kg repeat -10 min	Deakin	2000	TR	2	C	623	416	207	LB_S	LegEXT	Max 3	DYN	3	0.75	S	max # cans to max weight
Lift & Lower (R)	LC43/10	Wright	1984	TR	2	C	272	221	51	LB_S	LegEXT		ilm	3	0.42	S	max carries to max weight
Lift & Lower (R)	LC25/10	Wright	1984	TR	2	C	272	221	51	LB_S	LegEXT		ilm	3	0.34	S	max carries to max weight
Lift & Lower (R)	repeatbox lift: 20.45kg metal bx 1.32mH 10 min	Kraemer	1998	J	3	F	123	0	123	LB_S	Squat	1RM	weights	2	0.48	S	max # reps to max weight
Lift & Lower (R)	repeatbox lift: 20.45kg metal bx 1.32mH 10 min	Kraemer	1998	J	3	F	123	0	123	LB_S	Squat-Jump	1RM	PPScomputer	3	0.47	S	max # reps to max power
Lift & Lower (R)	jerrycan 20 kg repeat -10 min	Deakin	2000	TR	2	C	623	416	207	TR_E	SU	2 min	NA	1	0.49	S	max # cans to max #
Lift & Lower (R)	LC43/10	Wright	1984	TR	2	C	272	221	51	TR_E	SU	2 min	NA	1	0.20	S	max carries to max #
Lift & Lower (R)	LC25/10	Wright	1984	TR	2	C	272	221	51	TR_E	SU	2 min	NA	1	0.16	N	max carries to max #
Lift & Lower (R)	jerrycan 20 kg repeat -10 min	Deakin	2000	TR	2	C	623	416	207	TR_S	BackExt-DYN	Max 3	DYN	3	0.79	S	max # cans to max weight
Lift & Lower (R)	lift 48 ammo box ~21 kg lift 50 truck bed ~1.3m	Singh	1991	TR	3	M	116	116	0	TR_S	TrunkEXT		Electric DYN	3	-0.34	S	min time to max weight
Lift & Lower (R)	LC43/10	Wright	1984	TR	2	C	272	221	51	TR_S	TrunkEXT		ilm	3	0.63	S	max weight to max weight
Lift & Lower (R)	LC25/10	Wright	1984	TR	2	C	272	221	51	TR_S	TrunkEXT		ilm	3	0.62	S	max weight to max weight
Lift & Lower (R)	lift 48 ammo box ~21 kg lift 50 truck bed ~1.3m	Singh	1991	TR	3	M	116	116	0	TR_S	TrunkFlex		Electric DYN	3	-0.20	S	min time to max weight
Lift & Lower (R)	60 timed lifts of 22.7 kg block to truckbed ht 1.35 m	Stevenson89	1989	J	2	M	16	16	0	UB_E	ArmLift-End	Timed - 22.7kg - 60Rep	ILM Arm	3	0.71	S	best to best
Lift & Lower (R)	jerrycan 20 kg repeat -10 min	Deakin	2000	TR	2	C	623	416	207	UB_E	PullUp	Max	NA (Bar)	1	0.75	S	max # cans to max #
Lift & Lower (R)	jerrycan 20 kg repeat -10 min	Deakin	2000	TR	2	C	623	416	207	UB_E	PushUp	Max	NA	1	0.78	S	max # cans to max #
Lift & Lower (R)	repeatbox lift: 20.45kg metal bx 1.32mH 10 min	Kraemer	1998	J	3	F	123	0	123	UB_E	PushUp	2 min	NA	1	0.45	S	max # reps to max #reps
Lift & Lower (R)	LC43/10	Wright	1984	TR	2	C	272	221	51	UB_E	PushUp	2 min	NA	1	0.49	S	max carries to max #
Lift & Lower (R)	LC25/10	Wright	1984	TR	2	C	272	221	51	UB_E	PushUp	2 min	NA	1	0.45	S	max carries to max #
Lift & Lower (R)	jerrycan 20 kg repeat -10 min	Deakin	2000	TR	2	C	623	416	207	UB_S	Arm Pull	Max 3	UBSD	3	0.82	S	max # cans to max height (wt)
Lift & Lower (R)	repeatbox lift: 20.45kg metal bx 1.32mH 10 min	Kraemer	1998	J	3	F	123	0	123	UB_S	Arm Pull	1RM max weight	weights,PPS	2	0.52	S	max # reps to max weight
Lift & Lower (R)	lift 48 ammo box ~21 kg lift 50 truck bed ~1.3m	Singh	1991	TR	3	M	116	116	0	UB_S	ArmFlex		iso		-0.16	N	min time to max weight
Lift & Lower (R)	60 timed lifts of 22.7 kg block to truckbed ht 1.35 m	Stevenson89	1989	J	2	M	16	16	0	UB_S	ArmLift	Max 1.83 m; 3 practice	ILM Arm	3	0.71	S	best-to best' (min time to max w
Lift & Lower (R)	60 timed lifts of 22.7 kg block to truckbed ht 1.35 m	Stevenson89	1989	J	2	M	16	16	0	UB_S	ArmLift	Max 1.52m; 3 practice	ILM Arm	3	0.67	S	best-to best' (min time to max w
Lift & Lower (R)	jerrycan 20 kg repeat -10 min	Deakin	2000	TR	2	C	623	416	207	UB_S	ArmPush	Max 3	UBSD	3	0.75	S	max # cans to max height (wt)
Lift & Lower (R)	repeatbox lift: 20.45kg metal bx 1.32mH 10 min	Kraemer	1998	J	3	F	123	0	123	UB_S	BenchPress	1RM max weight	weights,PPS	2	0.56	S	max # reps to max weight
Lift & Lower (R)	jerrycan 20 kg repeat -10 min	Deakin	2000	TR	2	C	623	416	207	UB_S	GRIP-Str	C-Sum 2	DYN	2	0.83	S	max # cans to max strength
Lift & Lower (R)	lift 48 ammo box ~21 kg lift 50 truck bed ~1.3m	Singh	1991	TR	3	M	116	116	0	UB_S	GRIP-Str	Avg R & L	DYN	2	-0.13	N	min time to max weight
Lift & Lower (R)	LC43/10	Wright	1984	TR	2	C	272	221	51	UB_S	GRIP-Str	?	DYN	2	0.63	S	max weight to max weight
Lift & Lower (R)	LC25/10	Wright	1984	TR	2	C	272	221	51	UB_S	GRIP-Str	?	DYN	2	0.57	S	max weight to max weight

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure
Lift & Lower (S)	Task=lift to elbow	Beckett	1988	TR	2	C	102	64	38	AER_tr	Distance run-timed	1.5M (2.4K)	NA	1	-0.34	S	max weight to min time
Lift & Lower (S)	Task lift to knuckle	Beckett	1988	TR	2	C	102	64	38	AER_tr	Distance run-timed	1.5M (2.4K)	NA	1	-0.36	S	max weight to min time
Lift & Lower (S)	1 RM box lift: 20.45kg metal bx 1.32mH	Kraemer	1998	J	3	F	123	0	123	AER_tr	Distance run-timed	2 M (3.2K)	NA	1	-0.03	N	max weight to min time
Lift & Lower (S)	hose carry/hoist	Williford	1999	J	2	M	91	91	0	AER_tr	Distance run-timed	1.5M (2.4K)	NA	1	0.30	S	min time to min time
Lift & Lower (S)	Max lift	Wright	1984	TR	2	C	272	221	51	AER_tr	Distance run-timed	2 M (3.2K)	NA	1	-0.44	S	max weight to min time
Lift & Lower (S)	Task lift to knuckle	Beckett	1988	TR	2	C	102	64	38	FLX	Sit&Rch	1sec, last of 3	NA	1	-0.18	N	max weight to max reach
Lift & Lower (S)	Task=lift to elbow	Beckett	1988	TR	2	C	102	64	38	FLX	Sit&Rch	1sec, last of 3	NA	1	-0.21	S	max weight to max reach
Lift & Lower (S)	hose carry/hoist	Williford	1999	J	2	M	91	91	0	FLX	Sit&Rch			1	-0.08	N	min time to max length
Lift & Lower (S)	1 RM box lift: 20.45kg metal bx 1.32mH	Kraemer	1998	J	3	F	123	0	123	LB_E	Squat-End	45kg lift .36m repeats	weights	2	0.43	S	max weight to max #reps
Lift & Lower (S)	Task=lift to elbow	Beckett	1988	TR	2	C	102	64	38	LB_E_n	Sprint_short	100 m	NA	1	-0.62	S	max weight to min time
Lift & Lower (S)	Task lift to knuckle	Beckett	1988	TR	2	C	102	64	38	LB_E_n	Sprint_short	100 m	NA	1	-0.64	S	max weight to min time
Lift & Lower (S)	Task=lift to elbow	Beckett	1988	TR	2	C	102	64	38	LB_S	Jump-SBJ	best of 3	NA	1	0.69	S	max weight to max height
Lift & Lower (S)	Task=lift to knuckle	Beckett	1988	TR	2	C	102	64	38	LB_S	Jump-SBJ	best of 3	NA	1	0.73	S	max weight to max height
Lift & Lower (S)	Task lift to knuckle	Beckett	1988	TR	2	C	102	64	38	LB_S	Jump-VJ	Max 2	Vertec dvc	2	0.53	S	max weight to max height
Lift & Lower (S)	Task=lift to elbow	Beckett	1988	TR	2	C	102	64	38	LB_S	Jump-VJ	Max 2	Vertec dvc	2	0.50	S	max weight to max height
Lift & Lower (S)	Max lift	Wright	1984	TR	2	C	272	221	51	LB_S	LegEXT		ilm	3	0.48	S	max weight to max weight
Lift & Lower (S)	1 RM box lift: 20.45kg metal bx 1.32mH	Kraemer	1998	J	3	F	123	0	123	LB_S	Squat	1RM	weights	2	0.58	S	max weight to max weight
Lift & Lower (S)	1 RM box lift: 20.45kg metal bx 1.32mH	Kraemer	1998	J	3	F	123	0	123	LB_S	Squat-Jump	1RM	PPScomputer	2	0.66	S	max weight to max power
Lift & Lower (S)	Task lift to knuckle	Beckett	1988	TR	2	C	102	64	38	TR_E	SU	2 min	NA	1	0.06	N	max weight to max #
Lift & Lower (S)	Task=lift to elbow	Beckett	1988	TR	2	C	102	64	38	TR_E	SU	2 min	NA	1	0.00	N	max weight to max #
Lift & Lower (S)	hose carry/hoist	Williford	1999	J	2	M	91	91	0	TR_E	SU	1 min		1	-0.22	S	min time to max #
Lift & Lower (S)	Max lift	Wright	1984	TR	2	C	272	221	51	TR_E	SU	2 min		1	0.23	S	max weight to max #
Lift & Lower (S)	Max lift	Wright	1984	TR	2	C	272	221	51	TR_S	TrunkEXT		ilm	3	0.57	S	max weight to max weight
Lift & Lower (S)	Task lift to knuckle	Beckett	1988	TR	2	C	102	64	38	UB_E	ArmCurl-End	ENDHoldCurl	ILM	3	-0.22	S	max weight to max time
Lift & Lower (S)	Task=lift to elbow	Beckett	1988	TR	2	C	102	64	38	UB_E	ArmCurl-End	ENDHoldCurl	ILM	3	-0.23	S	max weight to max time
Lift & Lower (S)	max weight box lift to truck bed ht 1.35 m	Stevenson89	1989	J	2	M	16	16	0	UB_E	ArmLift-End	Timed 22.7kg - 60Rep	ILM Arm	3	0.55	S	best to best'- max weight to min
Lift & Lower (S)	Task lift to knuckle	Beckett	1988	TR	2	C	102	64	38	UB_E	PullUp	max #/no time limit	NA (Bar)	1	0.62	S	max weight to max #
Lift & Lower (S)	Task lift to knuckle	Beckett	1988	TR	2	C	102	64	38	UB_E	PullUp	max #/no time limit	NA (Bar)	1	0.58	S	max weight to max #
Lift & Lower (S)	hose carry/hoist	Williford	1999	J	2	M	91	91	0	UB_E	PullUp	max #/no time limit		1	-0.30	S	min time to max #
Lift & Lower (S)	Task=lift to elbow	Beckett	1988	TR	2	C	102	64	38	UB_E	PushUp	2 min	NA	1	0.63	S	max weight to max #
Lift & Lower (S)	Task lift to knuckle	Beckett	1988	TR	2	C	102	64	38	UB_E	PushUp	2 min	NA	1	0.58	S	max weight to max #
Lift & Lower (S)	1 RM box lift: 20.45kg metal bx 1.32mH	Kraemer	1998	J	3	F	123	0	123	UB_E	PushUp	2 min	NA	1	0.10	N	max weight to max #
Lift & Lower (S)	hose carry/hoist	Williford	1999	J	2	M	91	91	0	UB_E	PushUp	max #/no time limit	NA	1	-0.35	S	min time to max #
Lift & Lower (S)	Max lift	Wright	1984	TR	2	C	272	221	51	UB_E	PushUp	2 min	NA	1	0.41	S	max weight to max #
Lift & Lower (S)	1 RM box lift: 20.45kg metal bx 1.32mH	Kraemer	1998	J	3	F	123	0	123	UB_S	Arm Pull	1RM max weight	weights,PPS	2	0.62	S	max weight to max weight
Lift & Lower (S)	Task lift to knuckle	Beckett	1988	TR	2	C	102	64	38	UB_S	ArmCurl	MxWt to Elb	ILM	3	0.80	S	max weight to max weight
Lift & Lower (S)	Task=lift to elbow	Beckett	1988	TR	2	C	102	64	38	UB_S	ArmCurl	MxWt to Elb	ILM	3	0.79	S	max weight to max weight
Lift & Lower (S)	max weight box lift to truck bed ht 1.35 m	Stevenson89	1989	J	2	M	16	16	0	UB_S	ArmLift	Max 1.52m; 3 practice	ILM Arm	3	0.71	S	max weight to max weight
Lift & Lower (S)	max weight box lift to truck bed ht 1.35 m	Stevenson89	1989	J	2	M	16	16	0	UB_S	ArmLift	Max 1.83 m; 3 practice	ILM Arm	3	0.69	S	max weight to max weight
Lift & Lower (S)	Task=lift to elbow	Beckett	1988	TR	2	C	102	64	38	UB_S	BenchPress	MaxWt 152cm	ILM	3	0.89	S	max weight to max weight
Lift & Lower (S)	Task lift to knuckle	Beckett	1988	TR	2	C	102	64	38	UB_S	BenchPress	MaxWt 152cm	ILM	3	0.85	S	max weight to max weight
Lift & Lower (S)	1 RM box lift: 20.45kg metal bx 1.32mH	Kraemer	1998	J	3	F	123	0	123	UB_S	BenchPress	1RM max weight	weights	2	0.58	S	max weight to max weight
Lift & Lower (S)	hose carry/hoist	Williford	1999	J	2	M	91	91	0	UB_S	GRIP-Str	C - avg R&L	Grip-Dyn	2	-0.55	S	min time to max weight
Lift & Lower (S)	Max lift	Wright	1984	TR	2	C	272	221	51	UB_S	GRIP-Str	?	Dyn	2	0.75	S	max weight to max weight

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure
Loaded March	load bearing task: 34 kg ruck 2M on 400m track	Kraemer	1998	J	3	F	123	0	123	AER_tr	Distance run-timed	2 M (3.2K)	NA	1	0.60	S	min time to min time
Loaded March	2km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegEXT-End	50 rep Mean @ 180d	CybexII Dyn	3	-0.05	N	min time to max weight
Loaded March	4km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegEXT-End	50 rep Mean @ 180d	CybexII Dyn	3	-0.07	N	min time to max weight
Loaded March	12km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegEXT-End	50 rep Mean @ 180d	CybexII Dyn	3	-0.40	N	min time to max weight
Loaded March	8km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegEXT-End	50 rep Mean @ 180d	CybexII Dyn	3	-0.64	S	min time to max weight
Loaded March	2km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegEXT-End	50 rep Peak @180d	CybexII Dyn	3	-0.12	N	min time to max weight
Loaded March	4km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegEXT-End	50 rep Peak @180d	CybexII Dyn	3	-0.25	N	min time to max weight
Loaded March	12km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegEXT-End	50 rep Peak @180d	CybexII Dyn	3	-0.49	S	min time to max weight
Loaded March	8km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegEXT-End	50 rep Peak @180d	CybexII Dyn	3	-0.51	S	min time to max weight
Loaded March	2km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegFLEX-End	50 rep Mean @ 180d	CybexII Dyn	3	-0.18	N	min time to max weight
Loaded March	4km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegFLEX-End	50 rep Mean @ 180d	CybexII Dyn	3	-0.22	N	min time to max weight
Loaded March	8km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegFLEX-End	50 rep Mean @ 180d	CybexII Dyn	3	-0.50	S	min time to max weight
Loaded March	12km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegFLEX-End	50 rep Mean @ 180d	CybexII Dyn	3	-0.55	S	min time to max weight
Loaded March	2km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegFLEX-End	50 rep Peak @180d	CybexII Dyn	3	-0.08	N	min time to max weight
Loaded March	4km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegFLEX-End	50 rep Peak @180d	CybexII Dyn	3	-0.27	N	min time to max weight
Loaded March	12km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegFLEX-End	50 rep Peak @180d	CybexII Dyn	3	-0.48	S	min time to max weight
Loaded March	8km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_E	LegFLEX-End	50 rep Peak @180d	CybexII Dyn	3	-0.61	S	min time to max weight
Loaded March	load bearing task: 34 kg ruck 2M on 400m track	Kraemer	1998	J	3	F	123	0	123	LB_E	Squat-End	45kg lift .36m repeats	weights	2	-0.46	S	min time to max #reps
Loaded March	Pack hike test: 4.8K w 20.4 kg load	Phillips	2010	J	2	M	38	38	0	LB_E	WallSit	max time	NA	1	-0.42	S	min time to max time
Loaded March	Pack hike test: 4.8K w 20.4 kg load	Phillips	2010	J	2	M	38	38	0	LB_S	Jump-SBJ	max distance	NA	1	-0.45	S	min time to max length
Loaded March	8km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegEXT	best of 3	CybexII Dyn	3	-0.40	N	min time to max weight
Loaded March	4km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegEXT	best of 3	CybexII Dyn	3	-0.24	N	min time to max weight
Loaded March	12km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegEXT	best of 3	CybexII Dyn	3	-0.34	N	min time to max weight
Loaded March	2km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegEXT	best of 3	CybexII Dyn	3	-0.14	N	min time to max weight
Loaded March	2km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegEXT	best of 3	CybexII Dyn	3	-0.08	N	min time to max weight
Loaded March	4km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegEXT	best of 3	CybexII Dyn	3	-0.15	N	min time to max weight
Loaded March	12km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegEXT	best of 3	CybexII Dyn	3	-0.45	S	min time to max weight
Loaded March	8km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegEXT	best of 3	CybexII Dyn	3	-0.46	S	min time to max weight
Loaded March	2km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegFLEX	best of 3	CybexII Dyn	3	-0.14	N	min time to max weight
Loaded March	4km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegFLEX	best of 3	CybexII Dyn	3	-0.18	N	min time to max weight
Loaded March	12km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegFLEX	best of 3	CybexII Dyn	3	-0.33	N	min time to max weight
Loaded March	8km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegFLEX	best of 3	CybexII Dyn	3	-0.54	N	min time to max weight
Loaded March	2km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegFLEX	best of 3	CybexII Dyn	3	-0.04	N	min time to max weight
Loaded March	4km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegFLEX	best of 3	CybexII Dyn	3	-0.32	N	min time to max weight
Loaded March	8km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegFLEX	best of 3	CybexII Dyn	3	-0.53	N	min time to max weight
Loaded March	12km march w 46kg (28kg pack/18kg gear)	Mello	1988	TR	1	M	28	28	0	LB_S	LegFLEX	best of 3	CybexII Dyn	3	-0.59	S	min time to max weight
Loaded March	load bearing task: 34 kg ruck 2M on 400m track	Kraemer	1998	J	3	F	123	0	123	LB_S	Squat	1RM	weights	2	-0.27	S	min time to max weight
Loaded March	load bearing task: 34 kg ruck 2M on 400m track	Kraemer	1998	J	3	F	123	0	123	LB_S	Squat-Jump	1RM	PPScomputer	2	-0.35	S	min time to max power
Loaded March	16 km march 5.5 km/h pace 24 kg gear	Singh	1991	TR	3	M	116	116	0	TR_S	TrunkEXT		Electric DYN	3	0.04	N	min time to max weight
Loaded March	16 km march 5.5 km/h pace 24 kg gear	Singh	1991	TR	3	M	116	116	0	TR_S	TrunkFlex		Electric DYN	3	0.03	N	min time to max weight
Loaded March	Pack hike test: 4.8K w 20.4 kg load	Phillips	2010	J	2	M	38	38	0	UB_E	GRIP-End	hold 25 kg force for time	Jamar dyn	2	-0.69	S	min time to max time
Loaded March	load bearing task: 34 kg ruck 2M on 400m track	Kraemer	1998	J	3	F	123	0	123	UB_E	PushUp	2 min	NA	1	-0.26	S	min time to max #
Loaded March	Pack hike test: 4.8K w 20.4 kg load	Phillips	2010	J	2	M	38	38	0	UB_E	PushUp	max #/no time limit	NA	1	-0.56	S	min time to max #
Loaded March	Pack hike test: 4.8K w 20.4 kg load	Phillips	2010	J	2	M	38	38	0	UB_E	WeightedHold	1.2 kg bar	weights	2	-0.42	S	min time to max time
Loaded March	load bearing task: 34 kg ruck 2M on 400m track	Kraemer	1998	J	3	F	123	0	123	UB_S	Arm Pull	1RM max weight	weights	2	-0.42	S	min time to max weight
Loaded March	16 km march 5.5 km/h pace 24 kg gear	Singh	1991	TR	3	M	116	116	0	UB_S	ArmFlex		iso	3	-0.05	N	min time to max weight
Loaded March	load bearing task: 34 kg ruck 2M on 400m track	Kraemer	1998	J	3	F	123	0	123	UB_S	BenchPress	1RM max weight	weights	2	-0.48	S	min time to max weight
Loaded March	Pack hike test: 4.8K w 20.4 kg load	Phillips	2010	J	2	M	38	38	0	UB_S	GRIP-Str	avg best r & l	Jamar dyn	3	-0.47	S	min time to max weight
Loaded March	16 km march 5.5 km/h pace 24 kg gear	Singh	1991	TR	3	M	116	116	0	UB_S	GRIP-Str	Avg R & L	DYN	2	0.04	N	min time to max weight
Loaded March	Pack hike test: 4.8K w 20.4 kg load	Phillips	2010	J	2	M	38	38	0	WB_E	BodyProneHold	max time	NA	1	-0.43	S	min time to max time

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure
Move fast (w/wo COD)	100 y sprint	Arvey/a	1992	J	1	U	161	U	U	AER_tr	Distance run-timed	1 M (1.6K)	NA	1	0.44	S	fastest time to fastest time
Move fast (w/wo COD)	100 y sprint	Arvey/i	1992	J	1	U	161	U	U	AER_tr	Distance run-timed	1 M (1.6K)	NA	1	0.46	S	min time to min time
Move fast (w/wo COD)	100 M sprint	Beckett	1988	TR	2	C	102	64	38	AER_tr	Distance run-timed	1.5M (2.4K)	NA	1	0.61	S	max weight to min time
Move fast (w/wo COD)	400m sprint	Harman	2008	J	2	M	32	32	0	AER_tr	Distance run-timed	2 M (3.2K)	NA	1	0.68	S	min time to min time
Move fast (w/wo COD)	Five 30 m rushes - prone then pivot 180 between	Harman	2008	J	2	M	32	32	0	AER_tr	Distance run-timed	2 M (3.2K)	NA	1	0.53	S	min time to min time
Move fast (w/wo COD)	300 m	Hoffman	2009	TR	2	U	128	?	?	AER_tr	Distance run-timed	1.5M (2.4K)	NA	1	0.69	S	min time to min time
Move fast (w/wo COD)	agility shuttle 30m w COD and zig zag	Hoffman	2009	TR	2	U	128	?	?	AER_tr	Distance run-timed	1.5M (2.4K)	NA	1	0.64	S	min time to min time
Move fast (w/wo COD)	shuttle: 20m rep>spd>fatigue/max	Aanstaad	2011	J	2	M	42	42	0	AER_v	Shuttle_eV02	20m rep>spd>fatigue/max	NA	1	0.69	S	VO2compared to estVO2
Move fast (w/wo COD)	100 M sprint	Beckett	1988	TR	2	C	102	64	38	FLX	Sit&Rch	1sec, last of 3	NA	1	0.14	N	min time to max reach
Move fast (w/wo COD)	300 m	Hoffman	2009	TR	2	U	128	?	?	FLX	Sit&Rch	inches	NA	1	-0.07	N	min time to max reach
Move fast (w/wo COD)	agility shuttle 30m w COD and zig zag	Hoffman	2009	TR	2	U	128	?	?	FLX	Sit&Rch	inches	NA	1	0.03	N	min time to max reach
Move fast (w/wo COD)	300 m	Hoffman	2009	TR	2	U	128	?	?	LB_E_n	Shuttle_agility time	5x30m(150y)wCOD &zig zag-'AG'	NA	1	0.69	S	min time to min time
Move fast (w/wo COD)	agility shuttle 30m w COD and zig zag	Hoffman	2009	TR	2	U	128	?	?	LB_E_n	Sprint_long	300 m w 2 right turns - 'ana'	NA	1	0.69	S	min time to min time
Move fast (w/wo COD)	40 m shuttle sprints	Thebault	2011	J	2	M	19	19	0	LB_S	Jump-CMJ			2	-0.46	S	min time to max length
Move fast (w/wo COD)	400m sprint	Harman	2008	J	2	M	32	32	0	LB_S	Jump-SBJ	Max 3	NA	1	-0.43	S	min time to max length
Move fast (w/wo COD)	Five 30 m rushes - prone then pivot 180 between	Harman	2008	J	2	M	32	32	0	LB_S	Jump-SBJ	Max 3	NA	1	-0.60	S	min time to max length
Move fast (w/wo COD)	40 m shuttle sprints	Thebault	2011	J	2	M	19	19	0	LB_S	Jump-Squat	no details		1	-0.43	N	min time to max height
Move fast (w/wo COD)	4 x 5m w COD	Barnes	2007	J	1	F	29	0	29	LB_S	Jump-VJ	Max 2	Vertec dvc	2	-0.58	S	min time to max height
Move fast (w/wo COD)	100 M sprint	Beckett	1988	TR	2	C	102	64	38	LB_S	Jump-VJ	Max 2	NA	1	-0.69	S	min time to max height
Move fast (w/wo COD)	400m sprint	Harman	2008	J	2	M	32	32	0	LB_S	Jump-VJ	Max 3	Vertec meter	2	-0.54	S	min time to max height
Move fast (w/wo COD)	Five 30 m rushes - prone then pivot 180 between	Harman	2008	J	2	M	32	32	0	LB_S	Jump-VJ	Max 3	Vertec meter	2	-0.72	S	min time to max height
Move fast (w/wo COD)	300 m	Hoffman	2009	TR	2	U	128	?	?	LB_S	Jump-VJ	Max 3	NA	1	-0.49	S	min time to max height
Move fast (w/wo COD)	agility shuttle 30m w COD and zig zag	Hoffman	2009	TR	2	U	128	?	?	LB_S	Jump-VJ	Max 3	NA	1	-0.61	S	min time to max #
Move fast (w/wo COD)	5 m sprint	McBride	2009	J	2	M	17	17	0	LB_S	Squat	1RM- 4 attempts Max	weights	2	-0.45	N	min time to max weight
Move fast (w/wo COD)	10 m sprint	McBride	2009	J	2	M	17	17	0	LB_S	Squat	1RM- 4 attempts Max	weights	2	-0.54	S	min time to max weight
Move fast (w/wo COD)	40 m sprint	McBride	2009	J	2	M	17	17	0	LB_S	Squat	1RM- 4 attempts Max	weights	2	-0.61	S	min time to max weight
Move fast (w/wo COD)	100 y sprint	Arvey/a	1992	J	1	U	161	U	U	TR_E	SU	1min	NA	1	0.39	S	min time to max #
Move fast (w/wo COD)	100 y sprint	Arvey/i	1992	J	1	U	161	U	U	TR_E	SU	1min	NA	1	0.40	S	min time to max #
Move fast (w/wo COD)	100 M sprint	Beckett	1988	TR	2	C	102	64	38	TR_E	SU	2 min	NA	1	-0.22	S	min time to max height
Move fast (w/wo COD)	400m sprint	Harman	2008	J	2	M	32	32	0	TR_E	SU	2 min	NA	1	-0.34	N	min time to max #
Move fast (w/wo COD)	Five 30 m rushes - prone then pivot 180 between	Harman	2008	J	2	M	32	32	0	TR_E	SU	2 min	NA	1	-0.37	S	min time to max #
Move fast (w/wo COD)	300 m	Hoffman	2008	J	2	U	133	?	?	TR_E	SU	2 min	NA	1	-0.38	S	min time to max #
Move fast (w/wo COD)	agility shuttle 30m w COD and zig zag	Hoffman	2008	J	2	U	134	?	?	TR_E	SU	2 min	NA	1	-0.53	S	min time to max #
Move fast (w/wo COD)	100 M sprint	Beckett	1988	TR	2	C	102	64	38	UB_E	Arm Curl-End	ENDHoldCurl	ILM	2	0.06	N	min time to max time
Move fast (w/wo COD)	100 y sprint	Arvey/a	1992	J	1	U	161	U	U	UB_E	ArmDip-End	1min	NA(Bench)	2	0.48	S	min time to max # reps
Move fast (w/wo COD)	100 y sprint	Arvey/i	1992	J	1	U	161	U	U	UB_E	ArmDip-End	1min	NA(Bench)	2	0.39	S	min time to max # reps
Move fast (w/wo COD)	100 M sprint	Beckett	1988	TR	2	C	102	64	38	UB_E	PullUp	max #/no time limit	NA (Bar)	1	-0.65	S	min time to max #
Move fast (w/wo COD)	100 M sprint	Beckett	1988	TR	2	C	102	64	38	UB_E	PushUp	2 min	NA	1	-0.66	S	min time to max #
Move fast (w/wo COD)	400m sprint	Harman	2008	J	2	M	32	32	0	UB_E	PushUp	2 min	NA	1	-0.51	S	min time to max #
Move fast (w/wo COD)	Five 30 m rushes - prone then pivot 180 between	Harman	2008	J	2	M	32	32	0	UB_E	PushUp	2 min	NA	1	-0.38	S	min time to max #
Move fast (w/wo COD)	300 m	Hoffman	2009	TR	2	U	128	?	?	UB_E	PushUp	max #/no time limit	NA	1	-0.45	S	min time to max #
Move fast (w/wo COD)	agility shuttle 30m w COD and zig zag	Hoffman	2009	TR	2	U	128	?	?	UB_E	PushUp	max #/no time limit	NA	1	-0.50	S	min time to max #
Move fast (w/wo COD)	100 M sprint	Beckett	1988	TR	2	C	102	64	38	UB_S	Arm Press	MaxWt 152cm	ILM	3	-0.35	S	min time to max weight
Move fast (w/wo COD)	300 m	Hoffman	2009	TR	2	U	128	?	?	UB_S	BenchPress	1RM	weights	2	-0.42	S	min time to max weight
Move fast (w/wo COD)	agility shuttle 30m w COD and zig zag	Hoffman	2009	TR	2	U	128	?	?	UB_S	BenchPress	1RM	weights	2	-0.53	S	min time to max weight
Move fast (w/wo COD)	100 y sprint	Arvey/a	1992	J	1	U	161	U	U	UB_S	GRIP-Str	Dominant hand	DYN	2	0.35	S	min time to max weight
Move fast (w/wo COD)	100 y sprint	Arvey/i	1992	J	1	U	161	U	U	UB_S	GRIP-Str	Dominant hand	DYN	2	0.10	N	min time to max weight
Move fast (w/wo COD)	27 kg load on zig zag run	Pandorf/Frykman	2001	J	1	F	12	0	12	WB_S/E/A	APFT	2MR/SU/PU	NA	1	-0.59	S	min time to max score

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure
Multi-Activity	Lift/carry hose/climb/drag	Rhea	2004	J	1	C	20	17	3	AER_d	Trdml run_max D	12 min D on Trdmll	Trdml	2	-0.32	N	min time to max distance
Multi-Activity	stairs/victim drag/ other (chop/sledgehammer)	Schonfeld	1990	J	2	M	20	20	0	AER_d	Trdml run_max D	distance to fatigue on Trdmll	Trdmll	3	-0.66	S	min time to max distance
Multi-Activity	OBST: hurdle, zigzag, climb 6 ft, sprint	Arvey/a	1992	J	1	U	161	U	U	AER_tr	Distance run-timed	1 M (1.6K)	NA	1	0.54	S	fastest time to fastest time
Multi-Activity	OBST: hurdle, zigzag, climb 6 ft, sprint	Arvey/i	1992	J	1	C	115	96	19	AER_tr	Distance run-timed	1 M (1.6K)	NA	1	0.54	S	min time to min time
Multi-Activity	hurdle,zig zag,crawl,shimmy, pipe, climb,stair	Harman	2008	J	2	M	32	32	0	AER_tr	Distance run-timed	2 M (3.2K)	NA	1	0.57	S	min time to min time
Multi-Activity	S1: sprints/carry/stairs/vault/climb/drag165	Hoffman	2009	TR	2	U	128	?	?	AER_tr	Distance run-timed	1.5M (2.4K)	NA	1	0.56	S	min time to min time
Multi-Activity	S2: run w COD/vault/block/strike/wrestle/drag	Hoffman	2009	TR	2	U	128	?	?	AER_tr	Distance run-timed	1.5M (2.4K)	NA	1	0.52	N	min time to min time
Multi-Activity	climb/drag/carry/push/pull/force/crawl	Williford	1999	J	2	M	91	91	0	AER_tr	Distance run-timed	1.5M (2.4K)	NA	1	0.38	S	min time to min time
Multi-Activity	stairs/victim drag/ other (chop/sledgehammer)	Schonfeld	1990	J	2	M	20	20	0	AER_v	Trdml run to eVO2	estimated from Trdmll	Trdmll	3	-0.63	S	min time to max VO2
Multi-Activity	S1: sprints/carry/stairs/vault/climb/drag165	Hoffman	2009	TR	2	U	128	?	?	FLX	Sit&Rch	inches	NA	1	0.05	N	min time to max reach
Multi-Activity	S2: run w COD/vault/block/strike/wrestle/drag	Hoffman	2009	TR	2	U	128	?	?	FLX	Sit&Rch	inches	NA	1	0.03	N	min time to max reach
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides	2008	J	2	M	38	38	0	FLX	Sit&Rch	reach in cm	NA	1	0.01	N	min time to max reach
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides8	2008	J	2	M	38	38	0	FLX	Sit&Rch	reach in cm	NA	1	-0.29	N	min time to max reach
Multi-Activity	climb/drag/carry/push/pull/force/crawl	Williford	1999	J	2	M	91	91	0	FLX	Sit&Rch		NA	1	-0.15	N	min time to max length
Multi-Activity	climb/drag/carry/push/pull/force/crawl	Williams-Bell	2008	J	3	C	41	32	14	LB_E	LegPress-End	reps to fatigue		2	0.45	S	min time to max #reps
Multi-Activity	Lift/carry hose/climb/drag	Rhea	2004	J	1	C	20	17	3	LB_E	Squat-End	max reps 61 kgs	weights	2	-0.47	S	min time to max #reps
Multi-Activity	S1: sprints/carry/stairs/vault/climb/drag165	Hoffman	2009	TR	2	U	128	?	?	LB_E_n	Shuttle_agility time	5x30m(150y)wCOD &zig zag-'AG'	NA	1	0.65	S	min time to min time
Multi-Activity	S2: run w COD/vault/block/strike/wrestle/drag	Hoffman	2009	TR	2	U	128	?	?	LB_E_n	Shuttle_agility time	5x30m(150y)wCOD &zig zag-'AG'	NA	1	0.64	S	min time to min time
Multi-Activity	S1: sprints/carry/stairs/vault/climb/drag165	Hoffman	2009	TR	2	U	128	?	?	LB_E_n	Sprint_long	300 m w 2 right turns - 'ana'	NA	1	0.66	S	min time to min time
Multi-Activity	S2: run w COD/vault/block/strike/wrestle/drag	Hoffman	2009	TR	2	U	128	?	?	LB_E_n	Sprint_long	300 m w 2 right turns - 'ana'	NA	1	0.66	S	min time to min time
Multi-Activity	Lift/carry hose/climb/drag	Rhea	2004	J	1	C	20	17	3	LB_E_n	Sprint_long	400 m	NA	1	0.79	S	min time to min time
Multi-Activity	OBST: hurdle, zigzag, climb 6 ft, sprint	Arvey/a	1992	J	1	U	161	U	U	LB_E_n	Sprint_short	100 yd	NA	1	0.83	S	fastest time to fastest time
Multi-Activity	OBST: hurdle, zigzag, climb 6 ft, sprint	Arvey/i	1992	J	1	C	115	96	19	LB_E_n	Sprint_short	100 yd	NA	1	0.55	S	min time to min time
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides	2011	J	2	M	67	67	0	LB_E_n	Step_ana power	1 min 'anaerobic' power	NA	1	-0.40	S	min time to max power
Multi-Activity	hurdle,zig zag,crawl,shimmy, pipe, climb,stair	Harman	2008	J	2	M	32	32	0	LB_S	Jump-SBJ	Max 3	NA	1	-0.69	S	min time to max length
Multi-Activity	hurdle,zig zag,crawl,shimmy, pipe, climb,stair	Harman	2008	J	2	M	32	32	0	LB_S	Jump-VJ	Max 3	Vertec meter	2	-0.62	S	min time to max height
Multi-Activity	S1: sprints/carry/stairs/vault/climb/drag165	Hoffman	2009	TR	2	U	128	?	?	LB_S	Jump-VJ	Max 3	NA	1	-0.53	S	min time to max height
Multi-Activity	S2: run w COD/vault/block/strike/wrestle/drag	Hoffman	2009	TR	2	U	128	?	?	LB_S	Jump-VJ	Max 3	NA	1	-0.55	S	min time to max height
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides	2011	J	2	M	67	67	0	LB_S	Jump-VJ	power calc	Vertec meter	3	-0.41	S	min time to max power
Multi-Activity	climb/drag/carry/push/pull/force/crawl	Williams-Bell	2008	J	3	C	41	32	14	LB_S	LegPress	1RM		2	0.62	S	min time to max weight
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides	2011	J	2	M	67	67	0	LB_S	Squat	1RM	bench	1	-0.22	N	min time to max weight
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides8	2008	J	2	M	38	38	0	LB_S	Squat	1RM	bench	1	-0.15	N	min time to max weight
Multi-Activity	Lift/carry hose/climb/drag	Rhea	2004	J	1	C	20	17	3	LB_S	Squat	5RM	weights	2	-0.30	N	min time to max weight
Multi-Activity	OBST: hurdle, zigzag, climb 6 ft, sprint	Arvey/a	1992	J	1	U	161	U	U	TR_E	SU	1min	NA	1	0.40	S	min time to max #
Multi-Activity	OBST: hurdle, zigzag, climb 6 ft, sprint	Arvey/i	1992	J	1	C	115	96	19	TR_E	SU	1min	NA	1	0.50	S	min time to max #
Multi-Activity	hurdle,zig zag,crawl,shimmy, pipe, climb,stair	Harman	2008	J	2	M	32	32	0	TR_E	SU	2 min	NA	1	-0.57	S	min time to max #
Multi-Activity	JTST#2: run w COD/vault/block/strike/wrestle/drag	Hoffman	2008	J	2	U	130	?	?	TR_E	SU	2 min	NA	1	-0.33	S	min time to max #
Multi-Activity	JTST#1: sprints/carry/stairs/vault/climb/drag165	Hoffman	2008	J	2	U	131	?	?	TR_E	SU	2 min	NA	1	-0.32	S	min time to max #
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides	2011	J	2	M	67	67	0	TR_E	SU	1 min	NA	1	-0.41	S	min time to max #
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides8	2008	J	2	M	38	38	0	TR_E	SU	1 min	NA	1	-0.17	N	min time to max #
Multi-Activity	14 kg load hurdle/zig-zag/crawl/sprint/climb	Pandorf/Frykman	2001	J	1	F	12	0	12	TR_E	SU	2 min	NA	1	-0.62	S	min time to max #
Multi-Activity	climb/drag/carry/push/pull/force/crawl	Williford	1999	J	2	M	91	91	0	TR_E	SU	1 min	NA	1	-0.32	S	min time to max #
Multi-Activity	Lift/carry hose/climb/drag	Rhea	2004	J	1	C	20	17	3	TR_E	SU-AbCurl	Max number reps	weights	2	-0.24	N	min time to max #reps
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides	2011	J	2	M	67	67	0	TR_S	Ab-ISO	3-5 sec best of 3	ABMED	3	-0.53	S	min time to max weight
Multi-Activity	Lift/carry hose/climb/drag	Rhea	2004	J	1	C	20	17	3	UB_E	ArmCurl-End	14 kg repeats	weights	2	-0.69	S	min time to max #reps
Multi-Activity	OBST: hurdle, zigzag, climb 6 ft, sprint	Arvey/a	1992	J	1	U	161	U	U	UB_E	ArmDip-End	1min	NA(Bench)	2	0.48	S	min time to max # reps
Multi-Activity	OBST: hurdle, zigzag, climb 6 ft, sprint	Arvey/i	1992	J	1	C	115	96	19	UB_E	ArmDip-End	1min	NA(Bench)	2	0.50	S	min time to max # reps
Multi-Activity	Lift/carry hose/climb/drag	Rhea	2004	J	1	C	20	17	3	UB_E	ArmRow-End	20.5 kg dumbells	weights	2	-0.61	S	min time to max #reps

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure
Multi-Activity	with60kg gear : stairs/crawl 38yd/drag 170lb victim	Myhre	1997	TR	2	C	279	272	7	**UB_E**	**BenchPress-End**	Max number reps with 80 lb barbe	weights	2	**-0.17**	S	min time to max #reps
Multi-Activity	Lift/carry hose/climb/drag	Rhea	2004	J	1	C	20	17	3	**UB_E**	**BenchPress-End**	Max # reps 45kg	weights	2	**-0.73**	S	min time to max #reps
Multi-Activity	climb/drag/carry/push/pull/force/crawl	Williams-Bell	2008	J	3	C	41	32	14	**UB_E**	**BenchPress-End**	reps to fatigue		2	**0.69**	S	min time to max #reps
Multi-Activity	Lift/carry hose/climb/drag	Rhea	2004	J	1	C	20	17	3	**UB_E**	**GRIP-End**	25kg force - hold	Dyn	2	**-0.25**	N	min time to max time
Multi-Activity	climb/drag/carry/push/pull/force/crawl	Williford	1999	J	2	M	91	91	0	**UB_E**	**PullUp**	max #/no time limit		1	**-0.38**	S	min time to max #
Multi-Activity	hurdle,zig zag,crawl,shimmy, pipe, climb,stair	Harman	2008	J	2	M	32	32	0	**UB_E**	**PushUp**	2 min	NA	2	**-0.43**	S	min time to max #
Multi-Activity	S2: run w COD/vault/block/strike/wrestle/drag	Hoffman	2009	TR	2	U	128	?	?	**UB_E**	**PushUp**	max #/no time limit	NA	2	**-0.45**	S	min time to max #
Multi-Activity	S1: sprints/carry/stairs/vault/climb/drag165	Hoffman	2009	TR	2	U	128	?	?	**UB_E**	**PushUp**	max #/no time limit	NA	2	**-0.49**	S	min time to max #
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides	2011	J	2	M	67	67	0	**UB_E**	**PushUp**	max #/no time limit	NA	2	**-0.27**	S	min time to max #
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides8	2008	J	2	M	38	38	0	**UB_E**	**PushUp**	max #/no time limit	NA	2	**-0.41**	S	min time to max #
Multi-Activity	14 kg load hurdle/zig-zag/crawl/sprint/climb	Pandorf/Frykman	2001	J	1	F	12	0	12	**UB_E**	**PushUp**	2 min	NA	2	**-0.54**	S	min time to max #
Multi-Activity	climb/drag/carry/push/pull/force/crawl	Williford	1999	J	2	M	91	91	0	**UB_E**	**PushUp**	max #/no time limit	NA	2	**-0.38**	S	min time to max #
Multi-Activity	Lift/carry hose/climb/drag	Rhea	2004	J	1	C	20	17	3	**UB_E**	**ShldrPr-End**	11 kg	weights	2	**-0.71**	S	min time to max #reps
Multi-Activity	with60kg gear : stairs/crawl 38yd/drag 170lb victim	Myhre	1997	TR	2	C	279	272	7	**UB_S**	**ArmCurl**	1RM	weights	2	**-0.25**	S	min time to max weight
Multi-Activity	with60kg gear : stairs/crawl 38yd/drag 170lb victim	Myhre	1997	TR	2	C	279	272	7	**UB_S**	**ArmRow**	1RM	weights	2	**-0.37**	S	min time to max weight
Multi-Activity	S2: run w COD/vault/block/strike/wrestle/drag	Hoffman	2009	TR	2	U	128	?	?	**UB_S**	**BenchPress**	1RM	weights	2	**-0.55**	S	min time to max weight
Multi-Activity	S1: sprints/carry/stairs/vault/climb/drag165	Hoffman	2009	TR	2	U	128	?	?	**UB_S**	**BenchPress**	1RM	weights	2	**-0.60**	S	min time to max weight
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides	2011	J	2	M	67	67	0	**UB_S**	**BenchPress**	IRM best of 3	Bench	2	**-0.31**	S	min time to max weight
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides8	2008	J	2	M	38	38	0	**UB_S**	**BenchPress**	1RM	weights	2	**-0.44**	S	min time to max weight
Multi-Activity	with60kg gear : stairs/crawl 38yd/drag 170lb victim	Myhre	1997	TR	2	C	279	272	7	**UB_S**	**BenchPress**	1RM	weights	2	**-0.18**	S	min time to max weight
Multi-Activity	Lift/carry hose/climb/drag	Rhea	2004	J	1	C	20	17	3	**UB_S**	**BenchPress**	5RM	weights	2	**-0.66**	S	min time to max weight
Multi-Activity	climb/drag/carry/push/pull/force/crawl	Williams-Bell	2008	J	3	C	41	32	14	**UB_S**	**BenchPress**	max weight		2	**0.65**	S	r2 (min time to max weight)
Multi-Activity	OBST: hurdle, zigzag, climb 6 ft, sprint	Arvey/a	1992	J	1	U	161	U	U	**UB_S**	**GRIP-Str**	Dominant hand	DYN	2	**0.26**	S	min time to max weight
Multi-Activity	OBST: hurdle, zigzag, climb 6 ft, sprint	Arvey/i	1992	J	1	C	115	96	19	**UB_S**	**GRIP-Str**	Dominant hand	DYN	2	**0.16**	S	min time to max weight
Multi-Activity	climb/hose carry/swing/hose pull/rescue drag	Michaelides	2011	J	2	M	67	67	0	**UB_S**	**GRIP-Str**	C - sum left and right	Grip-Dyn	2	**-0.16**	N	min time to max weight
Multi-Activity	Lift/carry hose/climb/drag	Rhea	2004	J	1	C	20	17	3	**UB_S**	**GRIP-Str**	no details	DYN	2	**-0.71**	S	min time to max force
Multi-Activity	climb/drag/carry/push/pull/force/crawl	Williams-Bell	2008	J	3	C	41	32	14	**UB_S**	**GRIP-Str**		Grip-Dyn	2	**0.69**	S	r2 (min time to max weight)
Multi-Activity	climb/drag/carry/push/pull/force/crawl	Williford	1999	J	2	M	91	91	0	**UB_S**	**GRIP-Str**	C - avg R&L	Grip-Dyn	2	**-0.54**	S	min time to max weight
Multi-Activity	stairs/victim drag/ other (chop/sledgehammer)	Schonfeld	1990	J	2	M	20	20	0	**WB_S**	**ArmLegPkEXTDYN**	avg of R&L arm& leg	Cybex	3	**-0.44**	N	min time to max weight
Multi-Activity	stairs/victim drag/ other (chop/sledgehammer)	Schonfeld	1990	J	2	M	20	20	0	**WB_S**	**ArmLegPkFlexDYN**	avg of R&L arm& leg	Cybex	3	**-0.54**	S	min time to max weight
Multi-Activity	27 kg load hurdle/zig-zag/crawl/sprint/climb	Pandorf/Frykman	2001	J	1	F	12	0	12	**WB_S/E/A**	**APFT**	2MR/SU/PU	NA	1	**-0.57**	S	min time to max score

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure
Stretcher Carry	Free carry half person wt 37 kg (82 lb)	Bilzon	2002	J	1	C	93	52	41	AER_d	Shuttle_max D	#20m sprint rep in 2min	2 minMx	1	0.60	S	work rate(m/s) to max #
Stretcher Carry	Stretcher plus body 41 kg (90 lb)	Bilzon	2002	J	1	C	93	52	41	AER_d	Shuttle_max D	#20m sprint rep in 2min	2 minMx	1	0.56	S	work rate(m/s) to max #
Stretcher Carry	82 kg mnqn/2prsn(45kg0 _4.5 km/hr to fatigue	Knapik	1998	J	1	C	11	7	4	AER_tr	Distance run-timed	2M (3.2K)	NA	1	-0.36	N	max time to min time
Stretcher Carry	Free carry half person wt 37 kg (82 lb)	Bilzon	2002	J	1	C	93	52	41	AER_v	Distance run_eV02	1.5M (2.4K) to est VO2m	NA	1	0.62	S	work rate(m/s) to max VO2
Stretcher Carry	Stretcher plus body 41 kg (90 lb)	Bilzon	2002	J	1	C	93	52	41	AER_v	Distance run_eV02	1.5M (2.4K) to est VO2m	NA	1	0.62	S	work rate(m/s) to max VO2
Stretcher Carry	landevac-41kg stretcher&wheels 750m	Deakin	2000	TR	2	C	623	416	207	AER_v	Shuttle_eV02	MaxSpd-mltstg20m repeat	CalcVO2Mx	2	-0.83	S	min time to max VO2
Stretcher Carry	landevac-41kg stretcher&wheels 750m	Deakin	2000	TR	2	C	623	416	207	AER_v	Step_eVO2	estimated from HR/Oxg cons	CalcVO2Mx	3	-0.69	S	min time to max VO2
Stretcher Carry	Stretcher plus body 41 kg (90 lb)	Bilzon	2002	J	1	C	93	52	41	LB_S	Jump-SBJ	Max 3	NA	1	0.81	S	work rate(m/s) to max height
Stretcher Carry	Free carry half person wt 37 kg (82 lb)	Bilzon	2002	J	1	C	93	52	41	LB_S	Jump-SBJ	Max 3	NA	1	0.84	S	work rate(m/s) to max height
Stretcher Carry	landevac-41kg stretcher&wheels 750m	Deakin	2000	TR	2	C	623	416	207	LB_S	Jump-VJ	Max 3	NA	1	-0.71	S	min time to max height
Stretcher Carry	landevac-41kg stretcher&wheels 750m	Deakin	2000	TR	2	C	623	416	207	LB_S	LegEXT	Max 3	DYN	2	-0.58	S	min time to max weight
Stretcher Carry	82 kg mnqn/2prsn(45kg0 _4.5 km/hr to fatigue	Knapik	1998	J	1	C	11	7	4	LB_S	Squat	1RM (kgs)	weights	2	0.53	N	max time to max weight
Stretcher Carry	Free carry half person wt 37 kg (82 lb)	Bilzon	2002	J	1	C	93	52	41	TR_E	SU	1 min	NA	1	0.56	S	work rate(m/s) to max #
Stretcher Carry	Stretcher plus body 41 kg (90 lb)	Bilzon	2002	J	1	C	93	52	41	TR_E	SU	1 min	NA	1	0.58	S	work rate(m/s) to max #
Stretcher Carry	landevac-41kg stretcher&wheels 750m	Deakin	2000	TR	2	C	623	416	207	TR_E	SU	2 min	NA	1	-0.56	S	min time to max #
Stretcher Carry	82 kg mnqn/2prsn(45kg0 _4.5 km/hr to fatigue	Knapik	1999	J	1	C	11	7	4	TR_E	SU	2 min	NA	1	-0.38	N	max time to max #
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	C	45	24	21	TR_E	SU	1 min	NA	1	-0.03	N	max work output to max #rep
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	F	21	0	21	TR_E	SU	1 min	NA	1	-0.02	N	max work output to max #rep
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	M	24	24	0	TR_E	SU	1 min	NA	1	-0.27	S	max work output to max #rep
Stretcher Carry	land evac only - 40 kg for .75km	Stevenson	1992	J	2	F	33	0	33	TR_E	SU	1 min	NA	1	-0.29	S	min time to max #
Stretcher Carry	land evac only - 40 kg for .75km	Stevenson	1992	J	2	M	99	99	0	TR_E	SU	1 min	NA	1	-0.25	N	min time to max #
Stretcher Carry	landevac-41kg stretcher&wheels 750m	Deakin	2000	TR	2	C	623	416	207	TR_S	BackExt-DYN	Max 3	DYN	3	-0.67	S	min time to max weight
Stretcher Carry	Free carry half person wt 37 kg (82 lb)	Bilzon	2002	J	1	C	93	52	41	UB_E	PullUp	1 min	NA	2	0.72	S	work rate(m/s) to max #
Stretcher Carry	Stretcher plus body 41 kg (90 lb)	Bilzon	2002	J	1	C	93	52	41	UB_E	PullUp	1 min	NA	2	0.72	S	work rate(m/s) to max #
Stretcher Carry	landevac-41kg stretcher&wheels 750m	Deakin	2000	TR	2	C	623	416	207	UB_E	PullUp	Max	NA (Bar)	1	-0.73	S	min time to max #
Stretcher Carry	Stretcher plus body 41 kg (90 lb)	Bilzon	2002	J	1	C	93	52	41	UB_E	PushUp	1 min	NA	1	0.70	S	work rate(m/s) to max #
Stretcher Carry	Free carry half person wt 37 kg (82 lb)	Bilzon	2002	J	1	C	93	52	41	UB_E	PushUp	1 min	NA	1	0.69	S	work rate(m/s) to max #
Stretcher Carry	landevac-41kg stretcher&wheels 750m	Deakin	2000	TR	2	C	623	416	207	UB_E	PushUp	Max	NA	1	-0.73	S	min time to max #
Stretcher Carry	82 kg mnqn/2prsn(45kg0 _4.5 km/hr to fatigue	Knapik	1999	J	1	C	11	7	4	UB_E	PushUp	2 min	NA	1	0.28	N	max time to max #
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	C	45	24	21	UB_E	PushUp	no details	NA	1	0.51	S	max work output to max #rep
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	F	21	0	21	UB_E	PushUp	no details	NA	1	0.21	N	max work output to max #rep
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	M	24	24	0	UB_E	PushUp	no details	NA	1	-0.15	N	max work output to max #rep
Stretcher Carry	land evac only - 40 kg for .75km	Stevenson	1992	J	2	F	33	0	33	UB_E	PushUp	1 min	NA	1	-0.35	N	min time to max #
Stretcher Carry	land evac only - 40 kg for .75km	Stevenson	1992	J	2	M	99	99	0	UB_E	PushUp	1 min	NA	1	-0.29	N	min time to max #
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	C	45	24	21	UB_E_n	Ergom	#rev at 30sec 600kpm	Erg/RehbTrn	3	0.63	S	max work output to max #rep
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	F	21	0	21	UB_E_n	Ergom	#rev at 30sec 600kpm	Erg/RehbTrn	3	0.73	S	max work output to max #rep
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	M	24	24	0	UB_E_n	Ergom	#rev at 30sec 600kpm	Erg/RehbTrn	3	0.31	S	max work output to max #rep
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	C	45	24	21	UB_S	Arm Lift	avg of 3 gauge pull(lift) from elbo	Chatillon g	2	0.67	S	max work output to max weight
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	F	21	0	21	UB_S	Arm Lift	avg of 3 gauge pull(lift) from elbo	Chatillon g	2	0.66	S	max work output to max weight
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	M	24	24	0	UB_S	Arm Lift	avg of 3 gauge pull(lift) from elbo	Chatillon g	2	0.36	S	max work output to max weight
Stretcher Carry	landevac-41kg stretcher&wheels 750m	Deakin	2000	TR	2	C	623	416	207	UB_S	Arm Pull	Max 3	UBSD	3	-0.62	S	min time to max height (wt)
Stretcher Carry	82 kg mnqn/2prsn(45kg0 _4.5 km/hr to fatigue	Knapik	1999	J	1	C	11	7	4	UB_S	Arm Pull	Lat Pull- 1RM	weights	2	0.77	S	max time to max weight
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	C	45	24	21	UB_S	Arm Pull	1 hand ea pull gauge max avg of 3	Chatillon g	2	0.71	S	max work output to max weight
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	F	21	0	21	UB_S	Arm Pull	1 hand ea pull gauge max avg of 3	Chatillon g	2	0.71	S	max work output to max weight
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	M	24	24	0	UB_S	Arm Pull	1 hand ea pull gauge max avg of 3	Chatillon g	2	0.49	S	max work output to max weight
Stretcher Carry	landevac-41kg stretcher&wheels 750m	Deakin	2000	TR	2	C	623	416	207	UB_S	ArmPush	Max 3	UBSD	3	-0.60	S	min time to max height (wt)
Stretcher Carry	82 kg mnqn/2prsn(45kg0 _4.5 km/hr to fatigue	Knapik	1999	J	1	C	11	7	4	UB_S	BenchPress	1RM	weights	2	0.70	S	max time to max weight

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure	best to best
Stretcher Carry	Free carry half person wt 37 kg (82 lb)	Bilzon	2002	J	1	C	93	52	41	UB_S	GRIP-Str	?	DYN	2	0.71	S	work rate(m/s) to max #	max-max
Stretcher Carry	Stretcher plus body 41 kg (90 lb)	Bilzon	2002	J	1	C	93	52	41	UB_S	GRIP-Str	?	DYN	2	0.71	S	work rate(m/s) to max #	max-max
Stretcher Carry	landevac-41kg stretcher&wheels 750m	Deakin	2000	TR	2	C	623	416	207	UB_S	GRIP-Str	C-Sum 2	DYN	2	-0.67	S	min time to max strength	min-max
Stretcher Carry	82 kg mnqn/2prsn(45kg0 _4.5 km/hr to fatigue	Knapik	1998	J	1	C	11	7	4	UB_S	GRIP-Str	Left hand	DYN	2	0.73	S	max time to max strength	max-max
Stretcher Carry	82 kg mnqn/2prsn(45kg0 _4.5 km/hr to fatigue	Knapik	1998	J	1	C	11	7	4	UB_S	GRIP-Str	Right hand	DYN	2	0.63	S	max time to max strength	max-max
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	C	45	24	21	UB_S	GRIP-Str	no details	DYN	2	0.71	S	max work output to max weight	max-max
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	F	21	0	21	UB_S	GRIP-Str	no details	DYN	2	0.45	S	max work output to max weight	max-max
Stretcher Carry	191 lb (25 strecher/166lb vict) 50 ft x 2: Work Output	Robertson	1985	TR	2	M	24	24	0	UB_S	GRIP-Str	no details	DYN	2	0.65	S	max work output to max weight	max-max
Stretcher Carry	land evac only - 40 kg for .75km	Stevenson	1992	J	2	F	33	0	33	UB_S	GRIP-Str	Max L&R	Grip-Dyn	2	-0.34	S	min time to max weight	min-max
Stretcher Carry	land evac only - 40 kg for .75km	Stevenson	1992	J	2	M	99	99	0	UB_S	GRIP-Str	Max L&R	Grip-Dyn	2	-0.36	N	min time to max weight	min-max
Stretcher Carry	Stretcher plus body 41 kg (90 lb)	Bilzon	2002	J	1	C	93	52	41	UB_S	Upright Pull	? 'field test: S & power'	?	2	0.79	S	work rate(m/s) to max #	max-max
Stretcher Carry	Free carry half person wt 37 kg (82 lb)	Bilzon	2002	J	1	C	93	52	41	UB_S	Upright Pull	? 'field test: S & power'	?	2	0.77	S	work rate(m/s) to max #	max-max

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure
Push/Pull	pull uncharged hose 65m	Rhea	2004	J	1	C	20	17	3	AER_d	Trdml run_max D	12 min D on Trdmll	Trdml	2	-0.05	N	min time to max distance
Push/Pull	hose pull adv 30 m	Williford	1999	J	2	M	91	91	0	AER_tr	Distance run-timed	1.5M (2.4K)	NA	1	0.10	N	min time to min time
Push/Pull	hose pull adv 30 m	Williford	1999	J	2	M	91	91	0	FLX	Sit&Rch		NA	1	-0.06	N	min time to max length
Push/Pull	pull uncharged hose 65m	Rhea	2004	J	1	C	20	17	3	LB_E	Squat-End	max reps 61 kgs	weights	2	-0.56	S	min time to max #reps
Push/Pull	pull uncharged hose 65m	Rhea	2004	J	1	C	20	17	3	LB_E_n	Sprint_long	400 m	NA	1	0.67	S	min time to min time
Push/Pull	Hose pull w hydrant hook up	Michaelides	2011	J	2	M	67	67	0	LB_E_n	Step_ana power	1 min 'anaerobic' power	NA	1	-0.26	N	min time to max power
Push/Pull	Charged hose advance - 15 m	Michaelides	2011	J	2	M	67	67	0	LB_E_n	Step_ana power	1 min 'anaerobic' power	NA	1	-0.27	S	min time to max power
Push/Pull	Hose pull w hydrant hook up	Michaelides	2011	J	2	M	67	67	0	LB_S	Jump-VJ	power calc	Vertec meter	3	-0.18	N	min time to max power
Push/Pull	Charged hose advance - 15 m	Michaelides	2011	J	2	M	67	67	0	LB_S	Jump-VJ	power calc	Vertec meter	3	-0.28	S	min time to max power
Push/Pull	Hose pull w hydrant hook up	Michaelides	2011	J	2	M	67	67	0	LB_S	Squat	1RM	bench	1	-0.05	N	min time to max weight
Push/Pull	Charged hose advance - 15 m	Michaelides	2011	J	2	M	67	67	0	LB_S	Squat	1RM	bench	1	-0.26	N	min time to max weight
Push/Pull	pull uncharged hose 65m	Rhea	2004	J	1	C	20	17	3	LB_S	Squat	5RM	weights	2	-0.48	S	min time to max weight
Push/Pull	Hose pull w hydrant hook up	Michaelides	2011	J	2	M	67	67	0	TR_E	SU	1 min	NA	1	-0.15	N	min time to max #
Push/Pull	Charged hose advance - 15 m	Michaelides	2011	J	2	M	67	67	0	TR_E	SU	1 min	NA	1	-0.30	S	min time to max #
Push/Pull	hose pull adv 30 m	Williford	1999	J	2	M	91	91	0	TR_E	SU	1 min	NA	1	-0.17	N	min time to max #
Push/Pull	pull uncharged hose 65m	Rhea	2004	J	1	C	20	17	3	TR_E	SU-AbCurl	Max number reps	weights	2	-0.22	N	min time to max #reps
Push/Pull	Hose pull w hydrant hook up	Michaelides	2011	J	2	M	67	67	0	TR_S	Ab-ISO	3-5 sec best of 3	ABMED	3	-0.41	S	min time to max weight
Push/Pull	Charged hose advance - 15 m	Michaelides	2011	J	2	M	67	67	0	TR_S	Ab-ISO	3-5 sec best of 3	ABMED	3	-0.43	S	min time to max weight
Push/Pull	pull uncharged hose 65m	Rhea	2004	J	1	C	20	17	3	UB_E	ArmCurl-End	14 kg repeats	weights	2	-0.67	S	min time to max #reps
Push/Pull	pull uncharged hose 65m	Rhea	2004	J	1	C	20	17	3	UB_E	ArmRow-End	20.5 kg dumbells	weights	1	-0.63	S	min time to max #reps
Push/Pull	pull uncharged hose 65m	Rhea	2004	J	1	C	20	17	3	UB_E	BenchPress-End	Max # reps 45kg	weights	2	-0.82	S	min time to max #reps
Push/Pull	pull uncharged hose 65m	Rhea	2004	J	1	C	20	17	3	UB_E	GRIP-End	25kg force - hold	DYN	1	-0.36	N	min time to max time
Push/Pull	hose pull adv 30 m	Williford	1999	J	2	M	91	91	0	UB_E	PullUp	max #/no time limit	bar	1	-0.30	S	min time to max #
Push/Pull	Hose pull w hydrant hook up	Michaelides	2011	J	2	M	67	67	0	UB_E	PushUp	max #/no time limit	NA	1	-0.13	N	min time to max #
Push/Pull	Charged hose advance - 15 m	Michaelides	2011	J	2	M	67	67	0	UB_E	PushUp	max #/no time limit	NA	1	-0.26	N	min time to max #
Push/Pull	hose pull adv 30 m	Williford	1999	J	2	M	91	91	0	UB_E	PushUp	max #/no time limit	NA	1	-0.27	S	min time to max #
Push/Pull	pull uncharged hose 65m	Rhea	2004	J	1	C	20	17	3	UB_E	ShldrPr-End	11 kg	weights	2	-0.75	S	min time to max #reps
Push/Pull	Hose pull w hydrant hook up	Michaelides	2011	J	2	M	67	67	0	UB_S	BenchPress	IRM best of 3	Bench	2	-0.22	N	min time to max weight
Push/Pull	Charged hose advance - 15 m	Michaelides	2011	J	2	M	67	67	0	UB_S	BenchPress	IRM best of 3	Bench	2	-0.36	S	min time to max weight
Push/Pull	pull uncharged hose 65m	Rhea	2004	J	1	C	20	17	3	UB_S	BenchPress	5RM	weights	2	-0.80	S	min time to max weight
Push/Pull	Charged hose advance - 15 m	Michaelides	2011	J	2	M	67	67	0	UB_S	GRIP-Str	C - sum left and right	Grip-Dyn	2	-0.22	N	min time to max weight
Push/Pull	Hose pull w hydrant hook up	Michaelides	2011	J	2	M	67	67	0	UB_S	GRIP-Str	C - sum left and right	Grip-Dyn	2	-0.36	S	min time to max weight
Push/Pull	pull uncharged hose 65m	Rhea	2004	J	1	C	20	17	3	UB_S	GRIP-Str	no details	DYN	2	-0.85	S	min time to max force
Push/Pull	hose pull adv 30 m	Williford	1999	J	2	M	91	91	0	UB_S	GRIP-Str	C - avg R&L	Grip-Dyn	2	-0.41	S	min time to max weight

The “Pipe-Walk” task was not included as one of the 12 common tasks/WTBD addressed in this study. It was only described in one of the studies selected.

Military TASK Group	Study Task Description	Author	Year	Typ	Rk	G	T#	M#	F#	TestGROU	TESTGen	TstDesc	TstEqpmt		r	Sig	task measure> fit test measure
Pipe Walk	14 kg load shimmy pipe 2m above ground -total D	Pandorf/Frykman	2001	J	1	F	12	0	12	**TR_E**	**SU**	2 min	NA	1	**0.64**	S	max length to max #
Pipe Walk	14 kg load shimmy pipe 2m above ground -total D	Pandorf/Frykman	2001	J	1	F	12	0	12	**UB_E**	**PushUp**	2 min	NA	1	**0.58**	S	max length to max #
Pipe Walk	14 kg load shimmy pipe 2m above ground -total D	Pandorf/Frykman	2001	J	1	F	12	0	12	**WB_S/E/A**	**APFT**	2MR/SU/PU	NA	1	**0.57**	S	max length to max score

APPENDIX G

Meta Analyses Results

The descriptive statistics presented in this Appendix are calculated correlation coefficient (r), number (N) of studies included in the calculated correlation coefficient, the confidence interval (CI) around the correlation coefficient, and the minimum and maximum (Min-Max) correlation coefficient.

- The N, CI, and Min-Max displayed are the results from the meta-analysis with all studies included. N, CI, and Min-Max statistics were not presented for the meta-analyses where one or more values were excluded.
- CIs were not able to be calculated for test and task combinations with only one study. Min-Max was also not presented for these studies.
- If the CI from the meta-analysis results contained 0, we are unable to conclude that the correlation coefficient is significantly different from 0.
- If '-' is presented for a test-task combination, no studies were compiled and therefore none were analyzed for this specific combination.

Table G-1. Meta Analyses Results: Tasks to Fitness Test Groups

		Aerobic (AER)	Flexability (FLX)	Lower Body Strength (LB-S)	Lower Body Endurance (LB-E)	Upper Body Strength (UB-S)	Upper Body Endurance (UB-E)	(Core) Trunk Strength (TR-S)	(Core) Trunk Endurance (TR-E)	Whole Body-Strength (WBs)	Whole Body - All
Lift & Lower (S)	**r**	**0.30**	**0.16**	**0.60**	**0.56**	**0.75**	**0.42**	**0.57**	**0.16**	-	-
	N	5	3	7	3	10	11	1	4		
	CI	(.15, .44)	(.05, .27)	(.52, .67)	(.48, .63)	(.66, .81)	(.31, .53)	-	(.08, .24)		
	Min-Max	.03 - .44	.08 - .21	.48 - .73	.43 - .64	.55 - .89	.10 - .63		.00 - .23		
Lift & Lower (Reps)	**r**	**0.60**	-	**0.57**	**0.55**	**0.61**	**0.62**	**0.56**	**0.29**	-	-
	N	5		6	1	11	6	5	3		
	CI	(.48, .70)		(.37, .72)	-	(.47, .73)	(.46, .74)	(.32, .73)	(.05, .51)		
	Min-Max	.49 - .75		.34 - .79		.13 - .83	.45 - .78	.20 - .79	.16 - .49		
Lift & Carry	**r**	**0.72**	**0.01**	**0.41**	**0.47**	**0.43** (0.46)	**0.50**	**0.41**	**0.25** (0.40)	-	-
	N	4	1	7	4	19	17	4	8		
	CI	(.51, .85)	-	(.20, .59)	(.35, .57)	(.34, .52)	(.37, .61)	(.18, .60)	(-.08, .52)		
	Min-Max	.12 - .89		.02 - .73	.34 - .59	-.10 - .68	.04 - .75	.24 - .59	-.32 - .63		
Casualty Drag	**r**	**0.32**	**0.06**	**0.27**	**0.46** (0.52)	**0.38**	**0.33** (0.36)	**0.27**	**0.16** (0.19)	**0.24**	-
	N	7	1	5	5	9	11	3	6	2	
	CI	(.23, .40)	-	(.14, .39)	(.20, .66)	(.24, .51)	(.19, .45)	(.16, .37)	(.08, .25)	(-.09, .52)	
	Min-Max	.23 - .47		.21 - .31	-.04 - .81	.05 - .68	-.08 - .68	.20 - .33	-.01 - .24	.20 - .28	
Stretcher Carry	**r**	**0.66**	-	**0.73**	-	**0.65**	**0.58** (0.61)	**0.67**	**0.31** (0.48)	-	-
	N	7		5		22	15	1	9		
	CI	(.53, .76)		(.62, .81)		(.60, .69)	(.48, .66)	-	(.12, .48)		
	Min-Max	.36 - .83		.53 - .84		.34 - .79	-.15 - .73		-.27 - .58		
Push/Pull	**r**	**0.09**	**0.06**	**0.21**	**0.35**	**0.46**	**0.46**	**0.42**	**0.20**	-	-
	N	2	1	5	4	7	9	2	4		
	CI	(-.10, .28)	-	(.10, .32)	(.21, .48)	(.28, .61)	(.29, .60)	(.27, .55)	(.08, .32)		
	Min-Max	.05 - .10		.05 - .48	.26 - .67	.22 - .85	.13 - .82	.41 - .43	.15 - .30		

Table G-1, cont'd. Meta Analyses Results: Tasks to Fitness Test Groups

		Aerobic (AER)	Flexability (FLX)	Lower Body Strength (LB-S)	Lower Body Endurance (LB-E)	Upper Body Strength (UB-S)	Upper Body Endurance (UB-E)	(Core) Trunk Strength (TR-S)	(Core) Trunk Endurance (TR-E)	Whole Body-Strength (WBs)	Whole Body - All
Loaded March	**r**	**0.60**		**0.32**	**0.38**	**0.28** (0.36)	**0.48**	**0.01** (0.04)			**0.43**
	N	1	-	19	18	5	4	2	-	-	1
	CI	-		(.25, .39)	(.31, .45)	(.04, .49)	(.25, .66)	(-.12, .13)			-
	Min-Max			.04 - .59	.05 - .64	-.04 - .48	.26 - .69	-.03 - .04			
Move fast	**r**	**0.59**	**0.08**	**0.58**	**0.69**	**0.35**	**0.47**		**0.39**		**0.59**
	N	8	3	13	2	5	9	-	7	-	1
	CI	(.51, .66)	(-.03, .18)	(.52, .63)	(.62, .75)	(.20, .49)	(.35, .57)		(.33, .45)		-
	Min-Max	.44 - .69	.03 - .14	.43 - .72	0.69	.10 - .53	.06 - .66		.22 - .53		
Climb	**r**	**0.55**	**0.25**	**-0.09** (.04)	**0.44**	**0.22** (0.30)	**0.46**	**0.38**	**0.43**	**0.46**	
	N	4	1	3	3	5	8	1	3	2	-
	CI	(.42, .66)	-	(-.24, .08)	(.26, .58)	(-.04, .45)	(.37, .54)	-	(.30, .54)	(.16, .68)	
	Min-Max	.36 - .63		-0.24 - 0.11	.39 - .63	-.16 - .46	.36 - .55		.21 - .50	.31 - .59	
Crawl	**r**	**0.80**		**0.65**		**0.49**	**0.66**	**0.64**	**0.48**		**0.67**
	N	2	-	2	-	5	5	1	5	-	1
	CI	(.72, .86)		(.39, .82)		(.38, .59)	(.50, .77)	-	(.22, .68)		-
	Min-Max	.76 - .83		.53 - .75		.13 - .60	.39 - .80		.18 - .62		
Dig	**r**	**0.62**		**0.53**	**0.15**	**0.44**	**0.38**	**0.47**	**0.21**		
	N	2	-	3	1	9	5	4	4	-	-
	CI	(.51, .71)		(.37, .65)	-	(.31, .56)	(.12, .59)	(.23, .65)	(-.04, .44)		
	Min-Max	.57 - .67		.22 - .65		.18 - .67	.02 - .66	.30 - .66	.04 - .42		
Multi-Activity	**r**	**0.52**	**0.08** (0.09)	**0.47**	**0.66**	**0.42**	**0.46**	**0.53**	**0.38**	**0.49**	**0.57**
	N	9	5	9	10	15	17	1	10	2	1
	CI	(.47, .58)	(-.02, .18)	(.36, .58)	(.62, .70)	(.33, .51)	(.38, .54)	-	(.32, .44)	(.20, .70)	-
	Min-Max	.32 - .66	-.01 - .29	.15 - .69	.40 - .83	.16 - .71	.17 - .73		.17 - .62	.44 - .54	

Table G-2. Meta Analyses Results: Task to Specific Tests.

		AER			LB-S		UB-S	UB-E	TR-E	LB_E
		AERtr	AERd	AERv	Jump-SBJ	Jump-Vert	Grip-S	Pushup	Situp	Sprint
Lift & Lower (S)	r	0.30			0.71	0.52	0.67	0.43	0.16	0.63
	N	5	-	-	2	2	2	5	4	2
	CI	(.15, .44)			(.63, .77)	(.41, .61)	(.43, .82)	(.25, .58)	(.08, .24)	(.54, .71)
	Min-Max	.03 - .44			.69 - .73	.50 - .53	.55 - .75	.10 - .63	.00 - .23	.62 - .64
Lift & Lower (Reps)	r	0.51		0.70		0.79	0.59	0.57	0.29	
	N	3	-	2	-	1	4	4	3	-
	CI	(45, .56)		(.59, 79)		-	(.27, .80)	(.31, .75)	(.05, .51)	
	Min-Max	.49 - .54		.65 - .75			.13 - .83	.45 - .78	.16 - .49	
Lift & Carry	r	0.67	0.12	0.84	0.45	0.43	0.36	0.47	0.26	0.55
	N	1	1	2	1	3	8	7	7	2
	CI	-	-	(.66, .93)	-	(-.09, .77)	(.13, .55)	(.22, .65)	(-.08, .55)	(.41, .66)
	Min-Max			.76 - .89		.02 - .73	-0.10 - 0.66	.27 - .75	-.32 - .63	.54 - .59
Casualty Drag	r	0.30	0.40	0.45	0.25	0.31	0.41	0.16	0.16	0.53
	N	4	2	1	1	2	6	3	5	3
	CI	(.21, .39)	(.09, .64)	-	-	(.12, .48)	(.24, .56)	(-.15, .45)	(.07, .25)	(.44, .61)
	Min-Max	.23 - .35	.33 - .47			0.31	.05 - .68	-.08 - .38	-.01 - .22	.49 - .81
Stretcher Carry	r	0.36	0.58	0.71	0.83	0.71	0.61	0.47	0.31	
	N	1	2	4	2	1	10	9	9	-
	CI	-	(.48, .67)	(.57, .81)	(.77, .87)	-	(.52, .70)	(.27, .64)	(.12, .48)	
	Min-Max		.56 - .60	.62 - .83	.81 - .84		.34 - .73	-.15 - .73	-.27 - .58	
		AERtr	AERd	AERv	Jump-SBJ	Jump-Vert	Grip-S	Pushup	Situp	Sprint
Loaded March	r	0.60			0.45		0.21	0.34		
	N	1	-	-	1	-	2	2	-	-
	CI	-			-		(-.31, .64)	(.19, .47)		
	Min-Max						-.04 - .47	.26 - .56		
Move fast	r	0.58		0.69	0.52	0.60	0.23	0.52	0.39	0.69
	N	7	-	1	2	6	2	5	7	1
	CI	(.49, .66)		-	(.31, .68)	(.54, .66)	(-.03, .46)	(.45, .59)	(.33, .45)	-
	Min-Max	.44 - .69			.43 - 60	.49 - .72	.10 - .35	.38 - .66	.22 - .53	
Climb	r	0.56	0.48	0.63		-0.24	0.23	0.44	0.45	0.63
	N	1	2	1	-	1	3	2	2	1
	CI	-	(.18, .69)	-		-	(-.20, .58)	(.30, .56)	(.31, .57)	-
	Min-Max		.36 - .58				-0.16 - 0.46	.39 - .47	.41 - .50	
Crawl	r			0.80		0.75	0.34	0.58	0.48	
	N	-	-	2	-	1	3	4	5	-
	CI			(.72, .86)		-	(-.07, .65)	(.21, .81)	(.22, .68)	
	Min-Max			.76 - .83			.13 - .60	.39 - .80	.18 - .62	
		AERtr	AERd	AERv	Jump-SBJ	Jump-Vert	Grip-S	Pushup	Situp	Sprint
Dig	r			0.62		0.47	0.38	0.29	0.21	
	N	-	-	2		2	5	4	4	-
	CI			(.51, .71)		(-.03, .78)	(.08, .62)	(-.19, .65)	(-.04, .44)	
	Min-Max			.57 - .67		.22 - .65	.18 - .67	.02 - .66	.04 - .42	
Multi-Activity	r	0.52	0.51	0.63	0.69	0.52	0.42	0.42	0.38	0.71
	N	6	2	1	1	4	6	7	9	5
	CI	(.46, .58)	(.22, .72)	-	-	(.44, .60)	(.22, .59)	(.35, .49)	(.32, .44)	(.66, .75)
	Min-Max	.38 - .57	.32 - .66			.41 - .62	.16 - .71	.27 - .54	.17 - .62	.55 - .83

APPENDIX H

Systematic Review Process - Lessons Learned

Consider a single person to conduct initial database search and document dated results. Having two investigators conduct separate searches of the same databases for different search terms and then combining findings was thought to save time and further minimize bias. However the process still proved to be more time consuming than may have been warranted. A single reviewer search of a database did save time and would have been adequate for all databases searches adequately documented. Some information such as the original data sources of certain articles/studies was also lost when separate reviewers' search results were merged. Having a single investigator perform the search may be more efficient for the purpose of establishing an initial list of citations.

Consider a more concise list of database/sources most pertinent to topic.
Investigators had identified numerous data sources to search in order to be as inclusive as possible, some sources proved to be much more difficult to access, especially as some were not free to the USAPHC. External sources (e.g. students and relatives of investigators who had access to data sources through universities) were utilized to access EMBASE and to obtain specific articles which would have either cost the USAPHC or at least taken additional time. Specifically, it was noted that EBSCO included MEDLINE along with several other databases. Yet MEDLINE was already included in PubMed, which included the largest portion of the overall (17,000) citations. EBSCO also proved to be relatively difficult to apply broad search criteria, though it was useful for obtaining specific articles once titles and authors are obtained. Another source discussed but not used in this review was Google Scholar. Though a quantified assessment of the sources of the final documents used was not performed, it appeared that the final selected studies would have been about the same if only PUBMed, DTIC, and grey sources were used. A review of published Systematic Reviews should be performed to identify most common data sources used. This list should be compared with resources readily available to USAPHC personnel e.g., Google Scholar or especially through the AMEDD Virtual Library – which can include data sources like PUBMED, MEDLINE, CINHAL, EMBASE, and OVID).

Sequential reviews can facilitate the process but can introduce bias. Using two separate investigators to sequentially review the initial list and eliminate based on titles/abstracts, and then the full articles, was considered a time-effective approach. For these reviews, the first investigator used a broader more inclusive review approach, and provided the second reviewer with an already condensed list from which to further eliminate articles. While this did save some time, the time-saving benefit of this process is overshadowed by the potential introduction of bias that the SR process attempts to eliminate. As such, this step is not recommended in future systematic reviews.

Data extraction. Data was initially extracted in an effort to follow a recommended step of Systematic Review guidelines [61, 62]. This resulted in the Excel sheet provided in **Appendix E** of this report which was intended to support the grading (scoring) process. However, in order to grade or score the studies, investigators found it was necessary to go back to original articles themselves. While this was facilitated by the use of hyperlinks to the .pdf files of each article/study listed in the initial Excel file, the extracted data in the file itself was not adequate or in a format needed for the analysis. As a result, the format and type of data required for the meta-analyses eventually required the creation of a whole new file (**Appendix F**). This experience suggests it would have been more efficient to decide what data to extract and in what format after scoring the studies and coming to consensus of selected studies.

Minimize time setting scoring criteria, but consider intended interpretation of scores. The selection of the grading/scoring criteria also took a substantial amount of discussion time to finalize. After scoring the studies, investigators realized that the actual numeric scores were of

limited use. A review of other published systematic reviews did not make it clear how the scores should be used during the data analyses and interpretation. While the criteria did serve as a tool for the two investigators to discuss the worthiness of each study in a 'systematic' way, a simplified grading tool could have sufficed.

Other considerations to increase efficiency and quality:

- Before starting on a literature search, review internal materials or conduct a 'quick search' to support clear documentation of a problem/hypothesis and selection of comparable measurements. While the ultimate goal of a SR may be to do a meta-analysis, it is important to determine what types of available measure or metrics are available and whether and how they may lend themselves to a quantified meta-analysis.

- However, a key limitation of a process that requires focus on only specific studies with a specific measure (this case task- test Pearson correlation values), is the potential loss or oversight of other potentially relevant scientific literature. Studies that do not provide the right kind of quantified data for the Systematic Review analyses may provide substantial context that could be lost. This should be considered very early on before the search process; any potential critical studies or reviews (including already published Systematic Reviews!), especially if published in recent years, should be considered in the data interpretation and conclusions.

APPENDIX I

Physical Fitness as a Predictor of Injury – Analysis of Pilot APRT Data USAPHC-AIPH IPP Briefing, October 2012

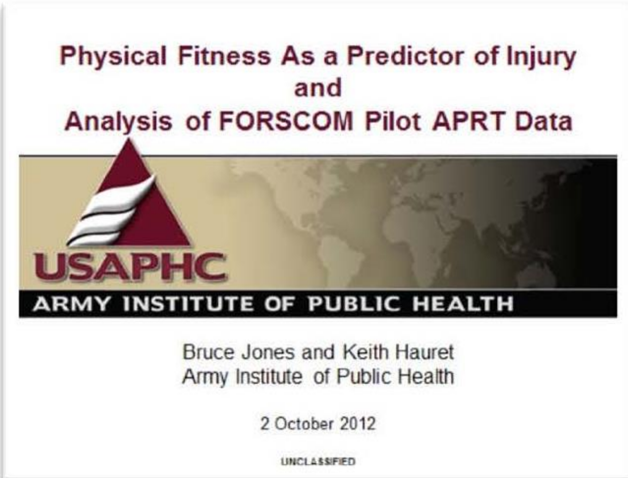
USAPHC- AIPH IPP (POC Keith Hauret) September - October 2012 background analyses, unpublished data used for briefing purposes.
Presented at the Baseline Soldier Physical Readiness Study Initial Planning Conference 2-3 OCT 12, Initial Military Training Center of Excellence; Ft Eustis VA

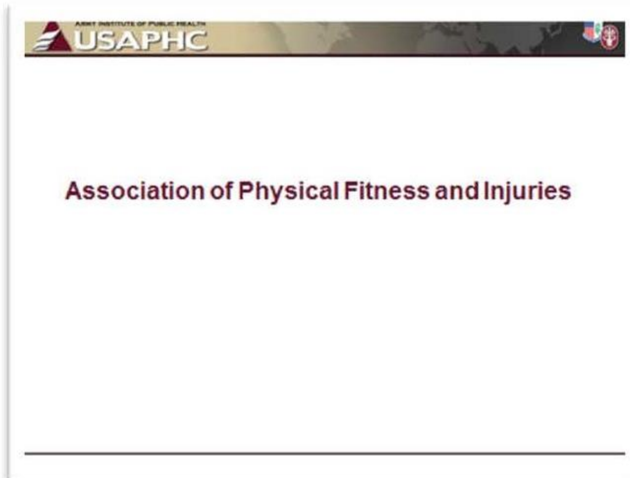
This appendix includes a PowerPoint slide set that was presented by Mr. Keith Hauret from the Injury Prevention Program, USAPHC, at the initial meeting for the Baseline Soldier Physical Requirements Study on 2 October 2012. This presentation has two components:

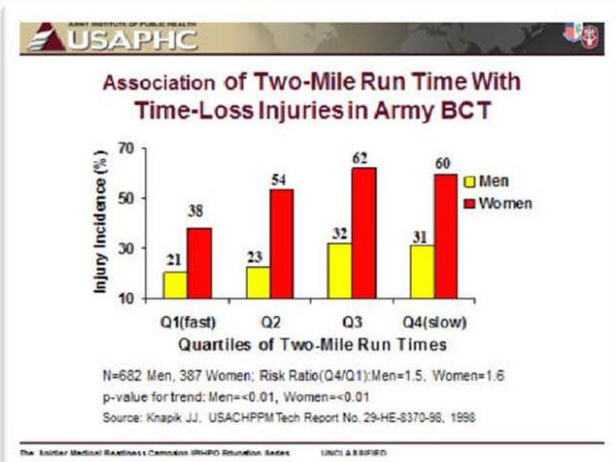
1) The association of the physical fitness tests and injury. Historical data from field studies and program evaluations by the Injury Prevention Program, US Army Public Health Command were presented to illustrate the finding that Soldiers who perform in the lowest quartile (i.e., slowest or least number of repetitions) on the 2-mile run, 300 yard shuttle run, 2-minute push-up test, and 2-minutes sit-up test have higher injury rates compared to those who ran faster or did more push-ups or sit-ups.

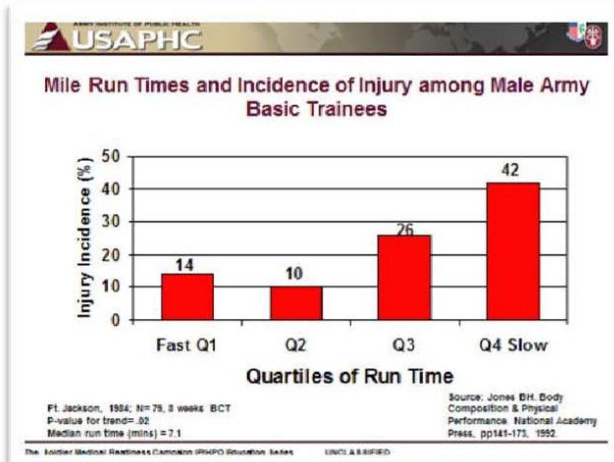
2) Summary of the analysis of TRADOC data by the Injury Prevention Program of the pilot evaluation of the proposed Army Physical Readiness Test (APRT) and Army Combat Readiness Test (ACRT) by Forces Command (FORSCOM) Soldiers. These tests were to be implemented Army-wide in October 2012. The slides show frequency distributions for the male and female performance on some of the events that comprised the proposed tests. On each slide, the red vertical line represents the cut-point for a 90% pass and 10% fail rate for the event using a gender-neutral standard. (Note: The scores for the current APFT events were established to allow 8% of the males and 8% of the females to fail the events using gender-specific scores[15]. These slides demonstrate differences in the proportion of males and females that would pass the events using a “gender-neutral standard” of the 10% fail rate applied to the overall male and female scores combined. For the existing APFT pushup and 2 mile run events, a much higher percentage of females compared with the percentage of males who would fail. The sit ups, however, do not present a gender difference. Though more substantial gender differences are seen with the pilot APRT long jump and pull up events; the gender impact is much lower for other proposed APRT events (e.g. rower, shuttle and half-mile run (~800 yards)). This suggests that use of certain events as a fitness standards may be considered ‘unfair’ if they are not made gender specific. Other events, such as sit ups, rower, or short runs (shuttle, ½ mile) may be more “gender-neutral.”

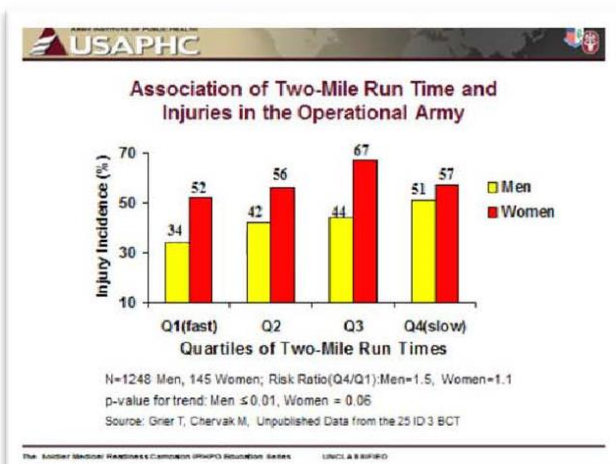
If tests are considered a means to assess ability to perform physical military tasks, it is necessary to determine which fitness tests are most associated with military tasks. To date to the association between these fitness tests and military tasks has not been validated.

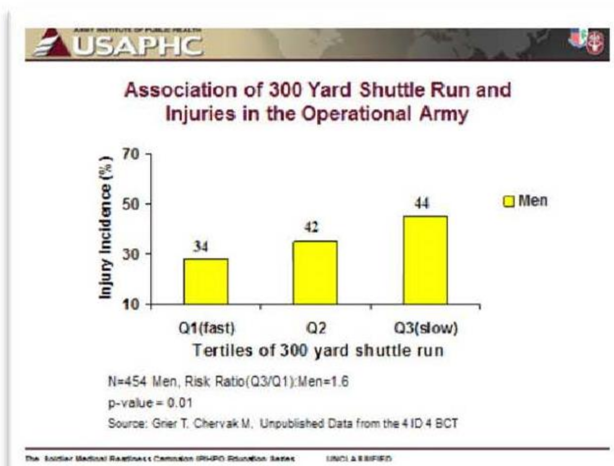

Physical Fitness As a Predictor of Injury
and
Analysis of FORSCOM Pilot APRT Data
USAPHC
ARMY INSTITUTE OF PUBLIC HEALTH
Bruce Jones and Keith Hauret
Army Institute of Public Health
2 October 2012
UNCLASSIFIED

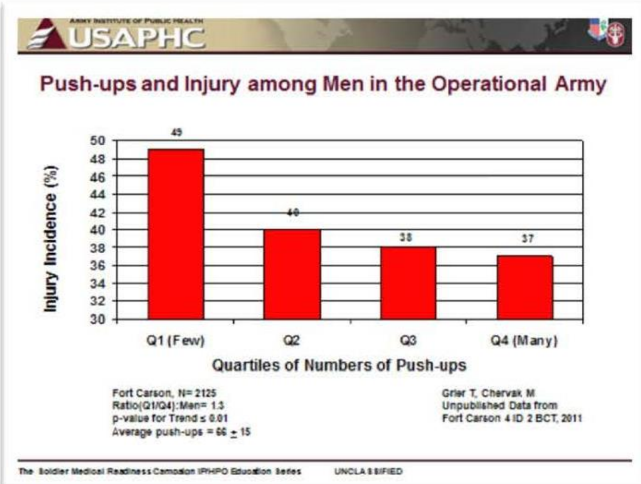

USAPHC
Association of Physical Fitness and Injuries

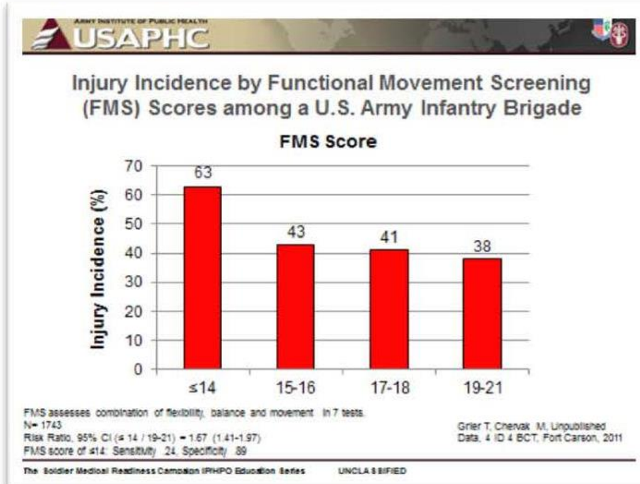

USAPHC
Association of Two-Mile Run Time With Time-Loss Injuries in Army BCT
Injury Incidence (%)
70
50
30
10
21
38
23
54
32
62
31
60
Men
Women
Q1(fast)
Q2
Q3
Q4(slow)
Quartiles of Two-Mile Run Times
N=682 Men, 387 Women; Risk Ratio(Q4/Q1):Men=1.5, Women=1.6
p-value for trend: Men=<0.01, Women=<0.01
Source: Knapik JJ. USACHPPM Tech Report No. 29-HE-8370-98, 1998

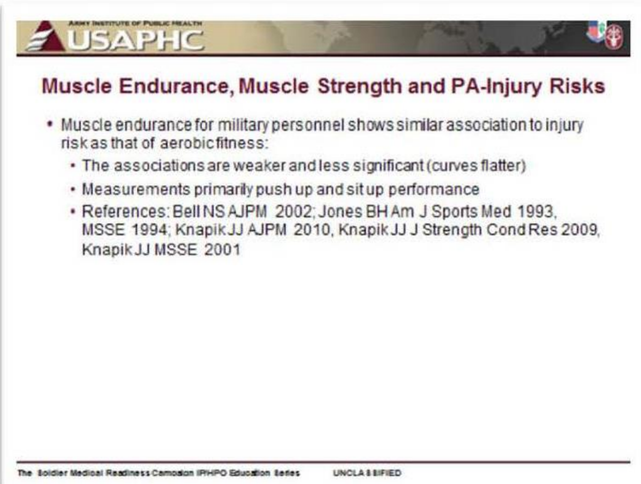

USAPHC
Mile Run Times and Incidence of Injury among Male Army Basic Trainees
Injury Incidence (%)
50
40
30
20
10
0
14
10
26
42
Fast Q1
Q2
Q3
Q4 Slow
Quartiles of Run Time
Ft. Jackson, 1984; N=79, 8 weeks BCT
P-value for trend=.02
Median run time (mins) = 7.1
Source: Jones BH. Body Composition & Physical Performance. National Academy Press, pp141-173, 1992.

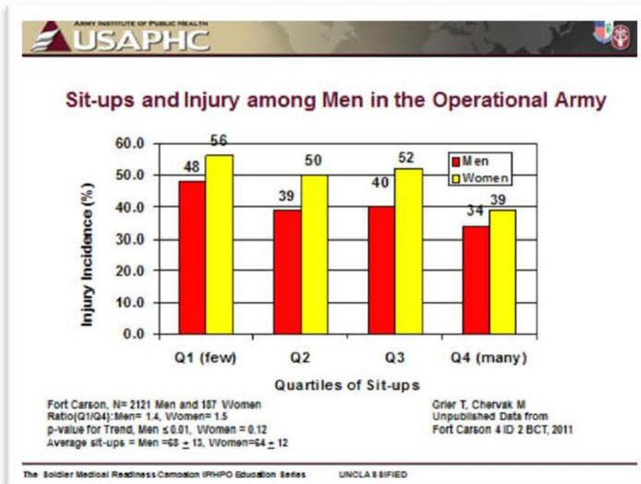

USAPHC
Association of Two-Mile Run Time and Injuries in the Operational Army
Injury Incidence (%)
70
50
30
10
34
52
42
56
44
67
51
57
Men
Women
Q1(fast)
Q2
Q3
Q4(slow)
Quartiles of Two-Mile Run Times
N=1248 Men, 145 Women; Risk Ratio(Q4/Q1):Men=1.5, Women=1.1
p-value for trend: Men ≤0.01, Women = 0.06
Source: Grier T, Chervak M, Unpublished Data from the 25 ID 3 BCT

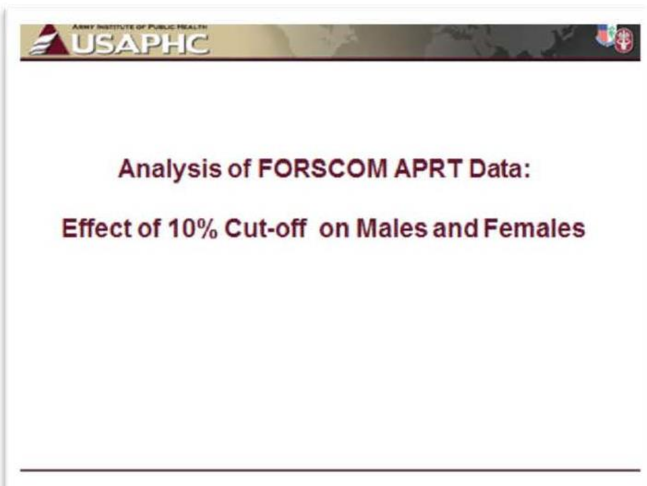

USAPHC
Association of 300 Yard Shuttle Run and Injuries in the Operational Army
Injury Incidence (%)
70
50
30
10
34
42
44
Men
Q1(fast)
Q2
Q3(slow)
Tertiles of 300 yard shuttle run
N=454 Men, Risk Ratio(Q3/Q1):Men=1.6
p-value = 0.01
Source: Grier T, Chervak M, Unpublished Data from the 4 ID 4 BCT

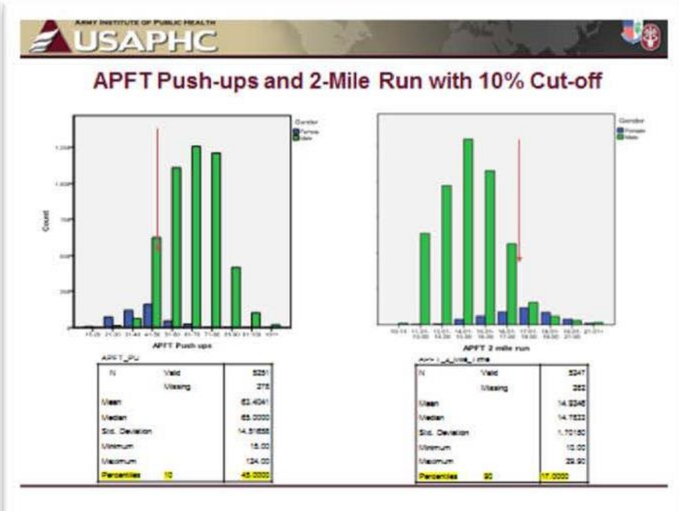

ARMY INSTITUTE OF PUBLIC HEALTH
USAPHC
Push-ups and Injury among Men in the Operational Army
Injury Incidence (%)
49
40
38
37
Q1 (Few)
Q2
Q3
Q4 (Many)
Quartiles of Numbers of Push-ups
Fort Carson, N= 2125
Ratio(Q1/Q4):Men= 1.3
p-value for Trend ≤ 0.01
Average push-ups = 66 ± 15
Grier T, Chervak M
Unpublished Data from
Fort Carson 4 ID 2 BCT, 2011
The Soldier Medical Readiness Campaign IPHPO Education Series
UNCLASSIFIED

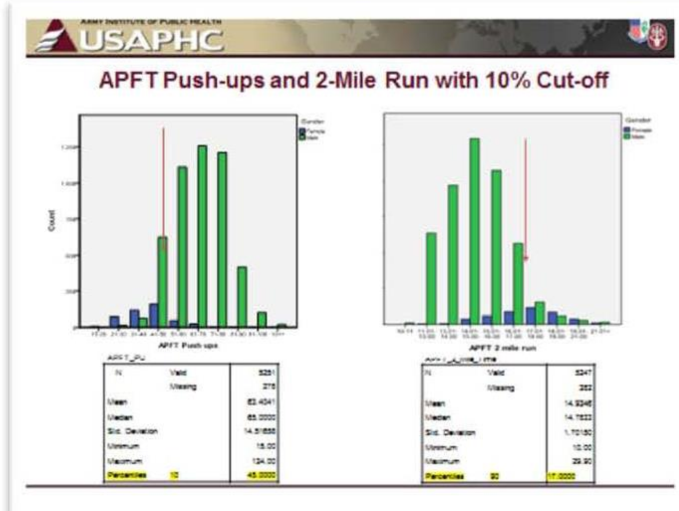

ARMY INSTITUTE OF PUBLIC HEALTH
USAPHC
Injury Incidence by Functional Movement Screening (FMS) Scores among a U.S. Army Infantry Brigade
FMS Score
Injury Incidence (%)
63
43
41
38
≤14
15-16
17-18
19-21
FMS assesses combination of flexibility, balance and movement in 7 tests.
N= 1743
Risk Ratio, 95% CI (≤ 14 / 19-21) = 1.67 (1.41-1.97)
FMS score of ≤14: Sensitivity .24, Specificity .89
Grier T, Chervak M, Unpublished Data, 4 ID 4 BCT, Fort Carson, 2011
The Soldier Medical Readiness Campaign IPHPO Education Series
UNCLASSIFIED

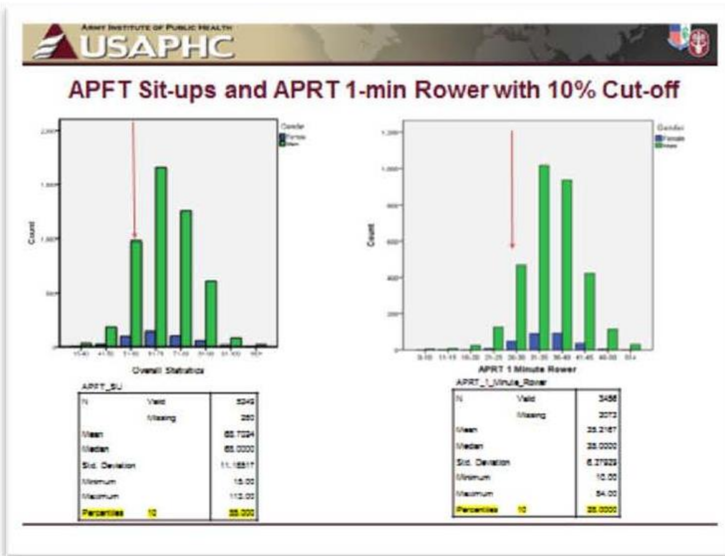

ARMY INSTITUTE OF PUBLIC HEALTH
USAPHC
Muscle Endurance, Muscle Strength and PA-Injury Risks
• Muscle endurance for military personnel shows similar association to injury risk as that of aerobic fitness:
• The associations are weaker and less significant (curves flatter)
• Measurements primarily push up and sit up performance
• References: Bell NS AJPM 2002; Jones BH Am J Sports Med 1993, MSSE 1994; Knapik JJ AJPM 2010, Knapik JJ J Strength Cond Res 2009, Knapik JJ MSSE 2001
The Soldier Medical Readiness Campaign IPHPO Education Series
UNCLASSIFIED

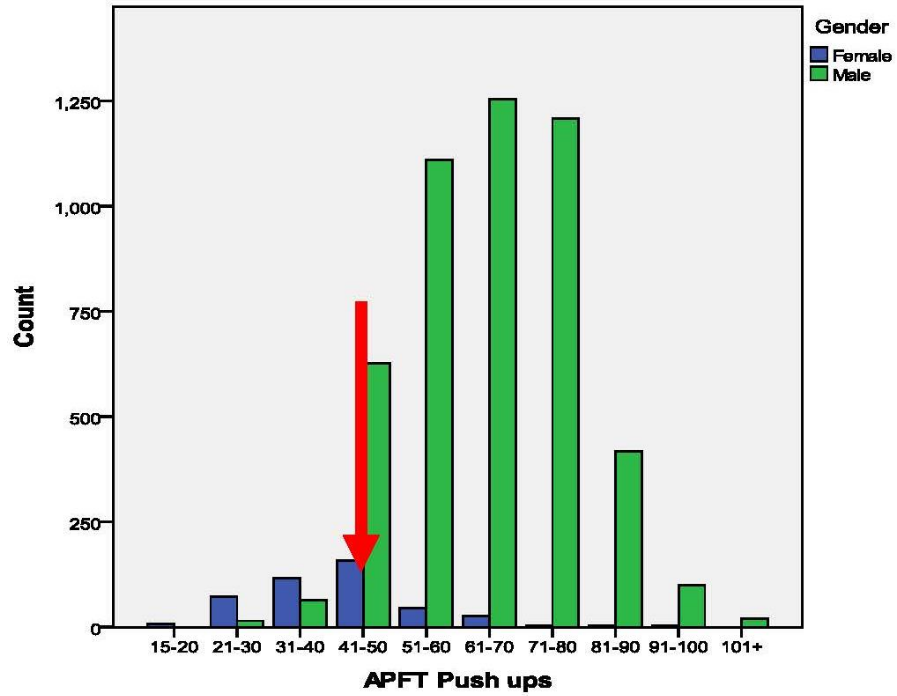

ARMY INSTITUTE OF PUBLIC HEALTH
USAPHC
Sit-ups and Injury among Men in the Operational Army
Injury Incidence (%)
Men
Women
48
56
39
50
40
52
34
39
Q1 (few)
Q2
Q3
Q4 (many)
Quartiles of Sit-ups
Fort Carson, N= 2121 Men and 187 Women
Ratio(Q1/Q4):Men= 1.4, Women= 1.5
p-value for Trend, Men ≤ 0.01, Women = 0.12
Average sit-ups = Men =68 ± 13, Women=64 ± 12
Grier T, Chervak M
Unpublished Data from
Fort Carson 4 ID 2 BCT, 2011
The Soldier Medical Readiness Campaign IPHPO Education Series
UNCLASSIFIED


ARMY INSTITUTE OF PUBLIC HEALTH
USAPHC
Analysis of FORSCOM APRT Data:
Effect of 10% Cut-off on Males and Females


ARMY INSTITUTE OF PUBLIC HEALTH
USAPHC
APFT Push-ups and 2-Mile Run with 10% Cut-off


ARMY INSTITUTE OF PUBLIC HEALTH
USAPHC
APFT Push-ups and 2-Mile Run with 10% Cut-off


ARMY INSTITUTE OF PUBLIC HEALTH
USAPHC
APFT Sit-ups and APRT 1-min Rower with 10% Cut-off



Overall Statistics

APFT_PU

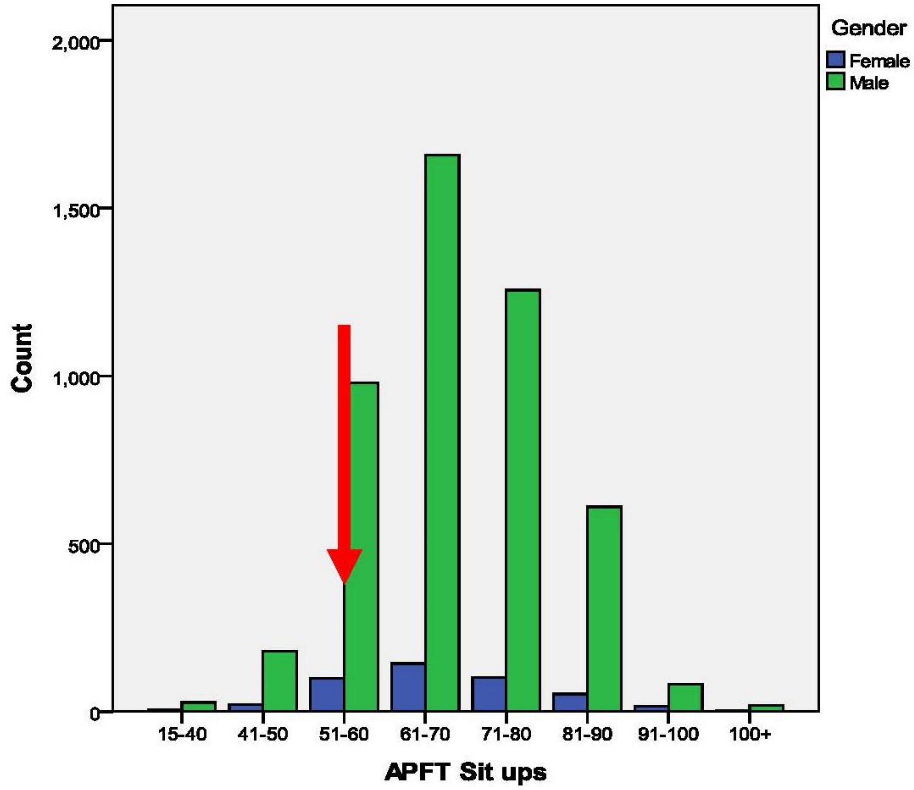
N	Valid	5251
	Missing	278
Mean		63.4041
Median		65.0000
Std. Deviation		14.51658
Minimum		15.00
Maximum		124.00
Percentiles	10	45.0000

Statistics by Gender

APFT_PU

Female	N	Valid	437
		Missing	26
	Mean		42.4050
	Std. Deviation		13.07436
	Minimum		15.00
	Maximum		100.00
Male	N	Valid	4814
		Missing	252
	Mean		65.3103
	Std. Deviation		13.06552
	Minimum		22.00
	Maximum		124.00

Figure F-1. FORSCOM APFT Female and Male Scores – Push Ups (“10%” Point Shown By Arrow)



Overall Statistics

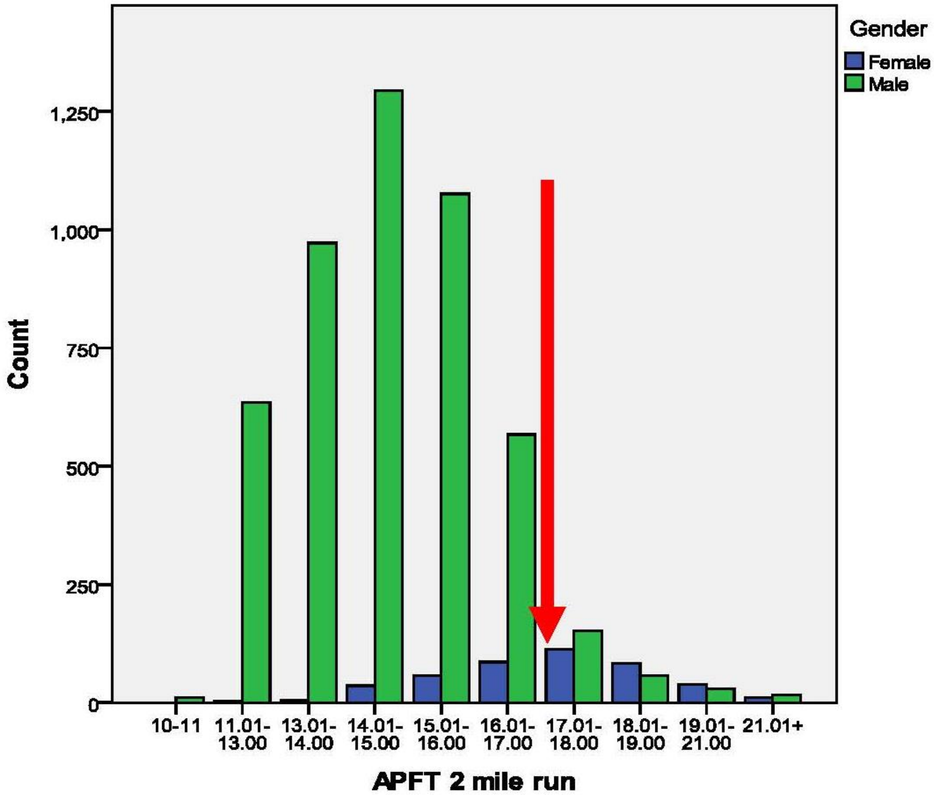
APFT_SU

N	Valid	5249
	Missing	280
Mean		68.7024
Median		68.0000
Std. Deviation		11.18517
Minimum		15.00
Maximum		113.00
Percentiles	10	55.000

APFT_SU Statistics by Gender

Female	N	Valid	437
		Missing	26
	Mean		68.3844
	Std. Deviation		12.28535
	Minimum		32.00
	Maximum		101.00
Male	N	Valid	4812
		Missing	254
	Mean		68.7313
	Std. Deviation		11.08079
	Minimum		15.00
	Maximum		113.00

Figure F-2. FORSCOM APFT Female and Male Scores – Sit Ups (“10%” Point Shown By Arrow)



Statistics by Gender

APFT_2_Mile_Time

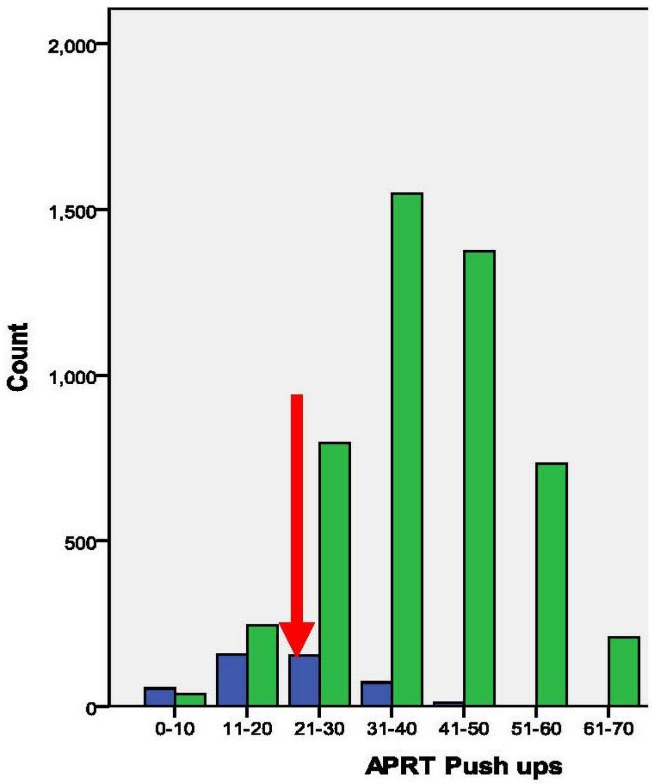
Female	N	Valid	435
		Missing	28
	Mean		17.2350
	Std. Deviation		1.71660
	Minimum		11.83
	Maximum		23.00
Male	N	Valid	4812
		Missing	254
	Mean		14.7158
	Std. Deviation		1.53778
	Minimum		10.00
	Maximum		29.90

Overall Statistics

APFT_2_Mile_Time

N	Valid	5247
	Missing	282
Mean		14.9246
Median		14.7833
Std. Deviation		1.70150
Minimum		10.00
Maximum		29.90
Percentiles	90	17.0000

Figure F-3. FORSCOM APFT Female and Male Scores – 2Mile Run ("10%" Point Shown By Arrow)



Overall Statistics

APRT_PU

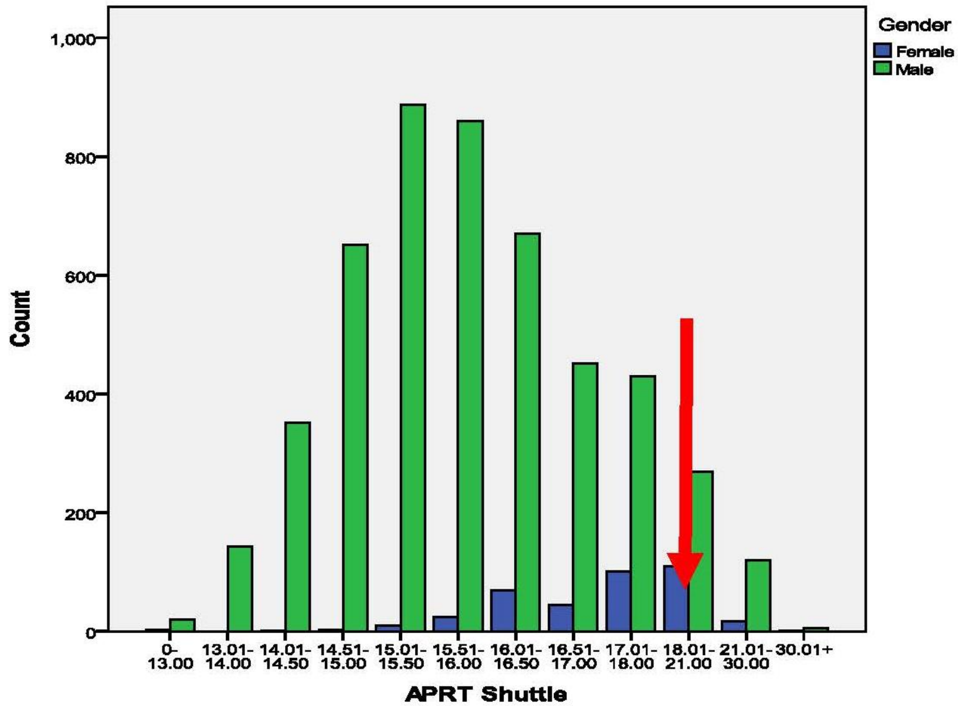
N	Valid	5462
	Missing	67
Mean		38.8495
Median		39.0000
Std. Deviation		13.42676
Minimum		1.00
Maximum		97.00
Percentiles	10	21.0000

Statistics by Gender

APRT_PU

Female	N	Valid	449
		Missing	14
	Mean		21.8129
	Std. Deviation		9.49016
	Minimum		1.00
	Maximum		45.00
Male	N	Valid	5013
		Missing	53
	Mean		40.3754
	Std. Deviation		12.65099
	Minimum		1.00
	Maximum		97.00

Figure F-4. FORSCOM APRT Pilot Event – Push Ups ("10%" Point Shown By Arrow)



Overall Statistics

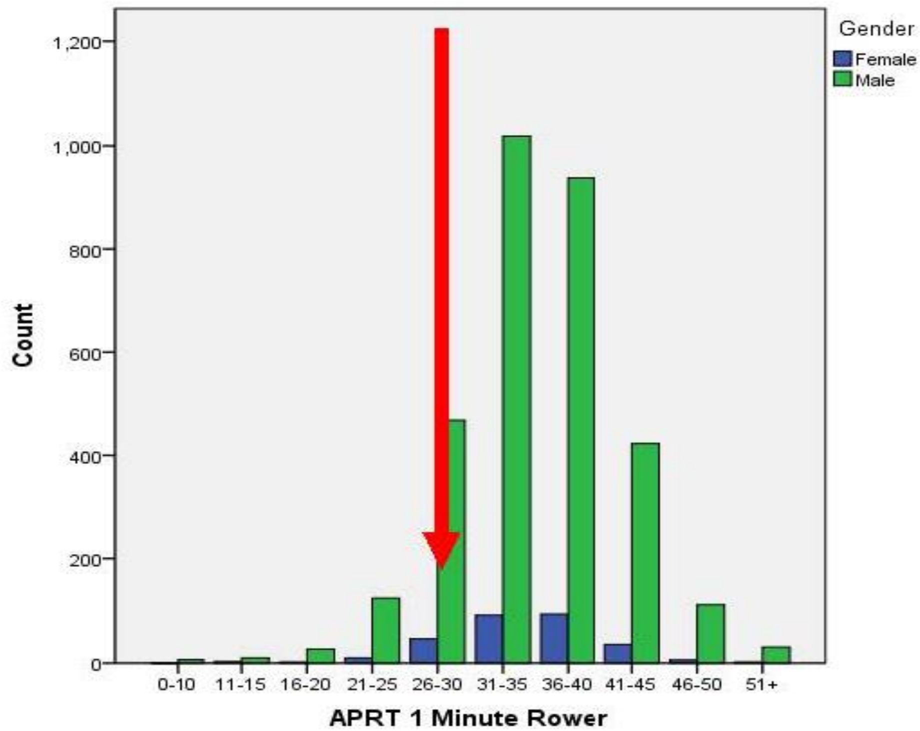
APRT_Shuttle

N	Valid	5238
	Missing	291
Mean		16.1965
Median		15.8800
Std. Deviation		1.90943
Minimum		9.45
Maximum		49.10
Percentiles	10	18.000

APRT_Shuttle **Statistics by Gender**

Female	N	Valid	381
		Missing	82
	Mean		17.7135
	Std. Deviation		2.10887
	Minimum		10.01
	Maximum		35.90
Male	N	Valid	4857
		Missing	209
	Mean		16.0775
	Std. Deviation		1.84099
	Minimum		9.45
	Maximum		49.10

Figure F-5. FORSCOM APRT Pilot Event - Shuttle ("10%" Point Shown By Arrow)



Statistics by Gender

APRT_1_Minute_Rower

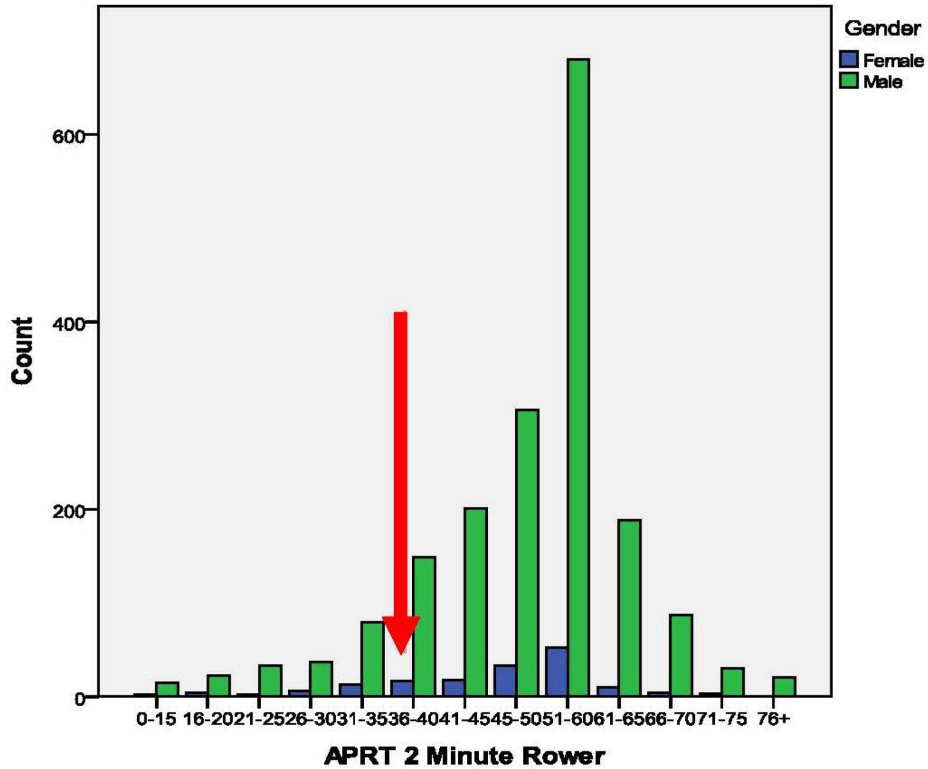
Female	N	Valid	294
		Missing	169
	Mean		34.8265
	Std. Deviation		6.03860
	Minimum		15.00
	Maximum		58.00
Male	N	Valid	3162
		Missing	1904
	Mean		35.2530
	Std. Deviation		6.30089
	Minimum		10.00
	Maximum		84.00

Overall Statistics

APRT_1_Minute_Rower

N	Valid	3456
	Missing	2073
Mean		35.2167
Median		35.0000
Std. Deviation		6.27929
Minimum		10.00
Maximum		84.00
Percentiles	10	28.0000

Figure F-6. FORSCOM APRT Pilot Event – 1 Minute Rower ("10%" Point Shown By Arrow)



Statistics by Gender

APRT_2_Minutes_Rower

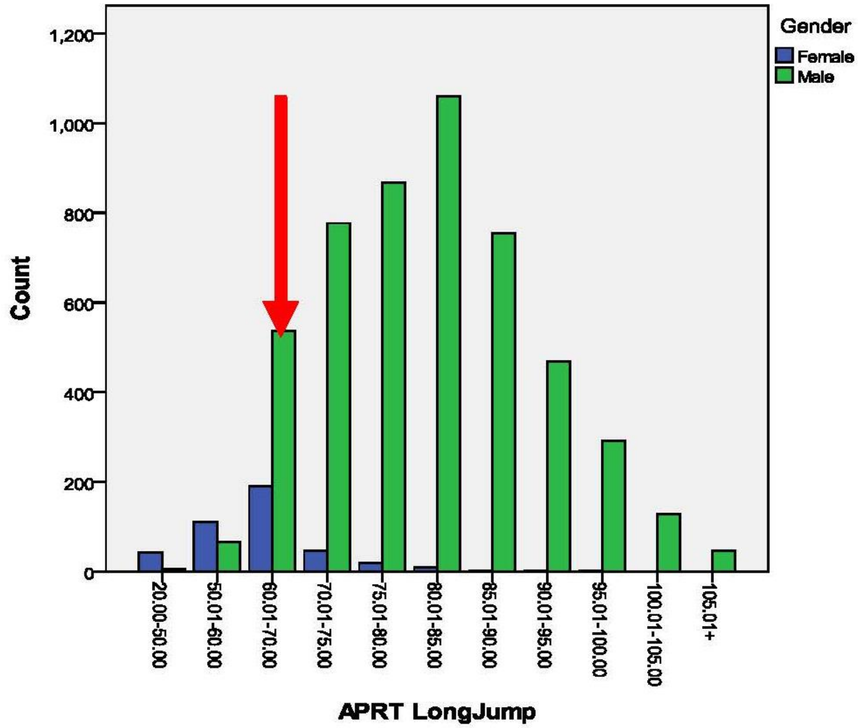
Female	N	Valid	164
		Missing	299
	Mean		47.5915
	Std. Deviation		12.10122
	Minimum		10.00
	Maximum		72.00
Male	N	Valid	1849
		Missing	3217
	Mean		50.5187
	Std. Deviation		11.88221
	Minimum		2.00
	Maximum		93.00

Overall Statistics

APRT_2_Minutes_Rower

N	Valid	2013
	Missing	3516
Mean		50.2802
Median		52.0000
Std. Deviation		11.92409
Minimum		2.00
Maximum		93.00
Percentiles	10	35.0000

Figure F-7. FORSCOM APRT Pilot Event– 2 Minute Rower ("10%" Point Shown By Arrow)



Overall Statistics

APRT Long Jump

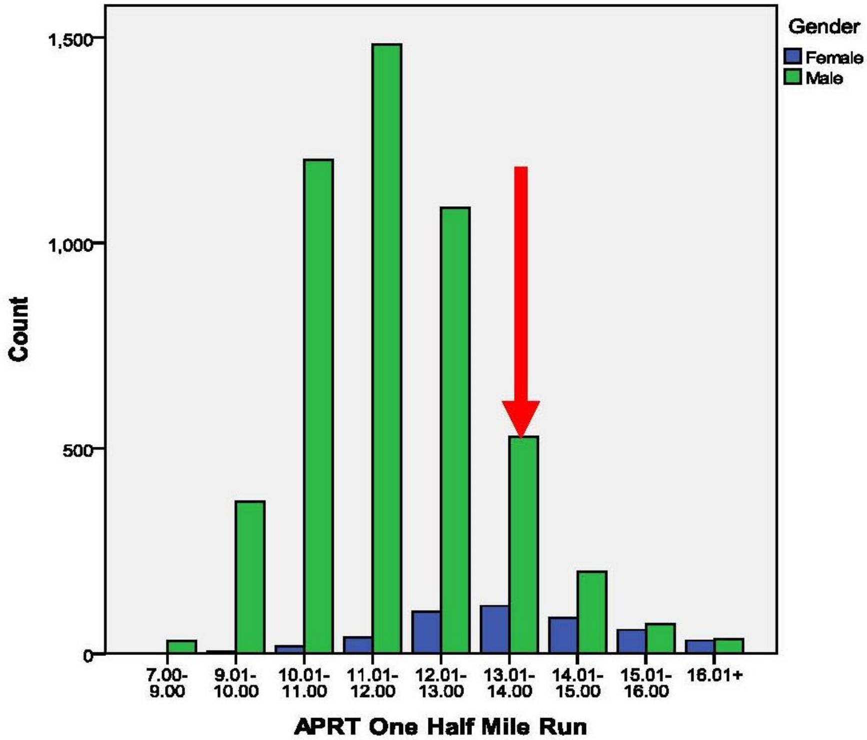
N	Valid	5426
	Missing	103
Mean		80.1758
Median		80.5000
Std. Deviation		15.21225
Minimum		10.39
Maximum		830.00
Percentiles	10	65.7500

Statistics by Gender

APRT Long Jump

Female	N	Valid	422
		Missing	41
	Mean		62.5078
	Std. Deviation		9.38106
	Minimum		24.75
	Maximum		97.00
Male	N	Valid	5004
		Missing	62
	Mean		81.6658
	Std. Deviation		14.66205
	Minimum		10.39
	Maximum		830.00

Figure F-8. FORSCOM APRT Pilot Event – Long Jump (“10%” Point Shown By Arrow)



Overall Statistics

APRT OneHalf Mile Time (min)

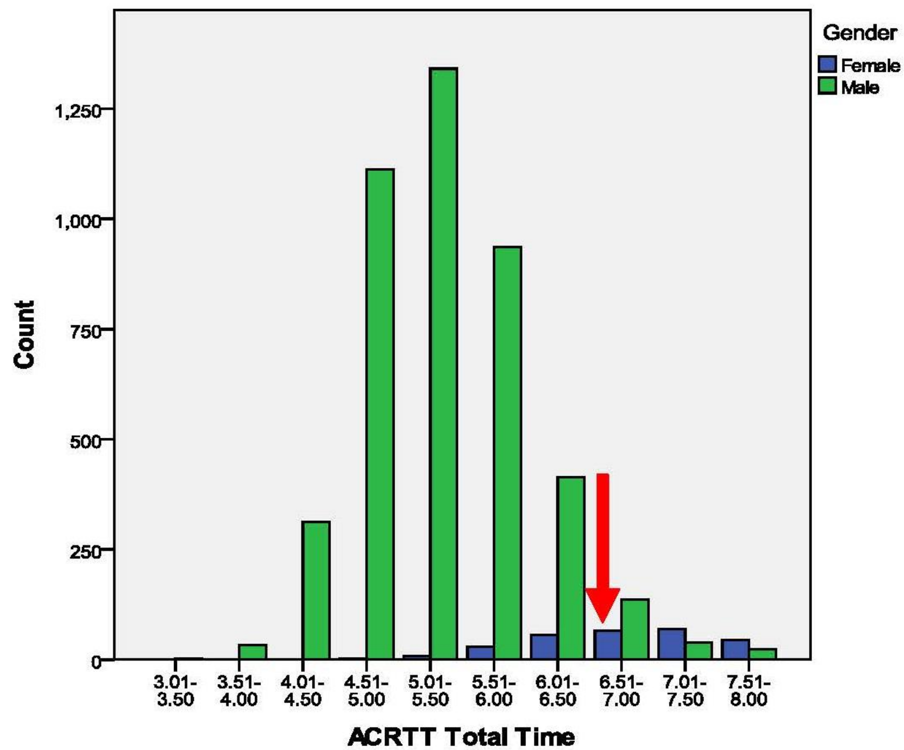
N	Valid	5464
	Missing	65
Mean		11.9189
Median		11.7167
Std. Deviation		1.51650
Minimum		7.38
Maximum		21.60
Percentiles	90	13.8667

Statistics by Gender

APRT OneHalf Mile Time (min)

Female	N	Valid	457
		Missing	6
	Mean		13.6932
	Std. Deviation		1.64989
	Minimum		9.22
	Maximum		20.20
Male	N	Valid	5007
		Missing	59
	Mean		11.7570
	Std. Deviation		1.39575
	Minimum		7.38
	Maximum		21.60

Figure F-9. FORSCOM APRT Pilot Event – ½ Mile Run ("10%" Point Shown By Arrow)



Overall Statistics

ACRT Total Time

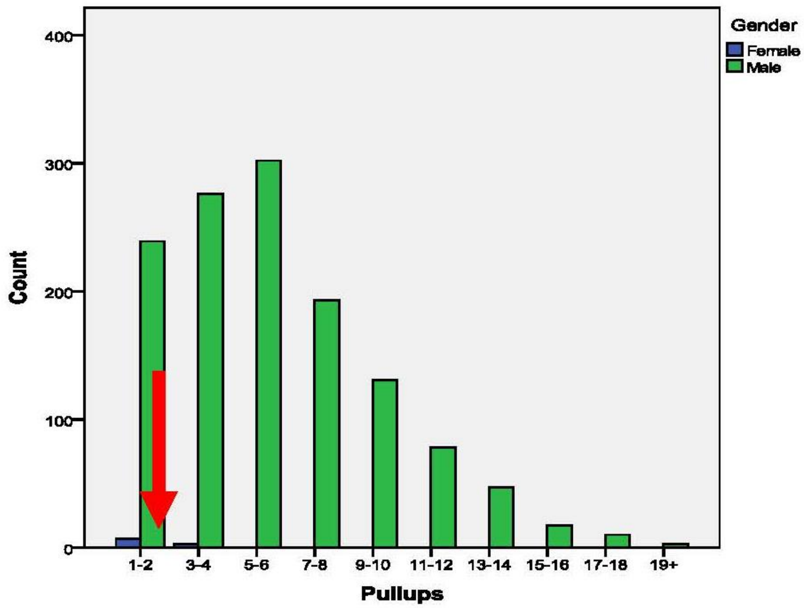
N	Valid	4703
	Missing	826
Mean		5.4788
Median		5.3333
Std. Deviation		.89775
Minimum		3.27
Maximum		17.28
Percentiles	90	6.5000

Statistics by Gender

ACRT Total Time

Female	N	Valid	343
		Missing	120
	Mean		7.1829
	Std. Deviation		1.07040
	Minimum		4.75
	Maximum		11.55
Male	N	Valid	4360
		Missing	706
	Mean		5.3447
	Std. Deviation		.73006
	Minimum		3.27
	Maximum		17.28

Figure F-10. FORSCOM Pilot ACRT- Total Time ("10%" Point Shown By Arrow)



Overall Statistics	Valid	1306
	Missing	4223
Mean		5.9043
Median		5.0000
Std. Deviation		3.68210
Minimum		1.00
Maximum		22.00
Percentiles	90	2

Pullups **Statistics by Gender**

Female	N	Valid	10
		Missing	453
	Mean		2.0000
	Std. Deviation		1.05409
	Minimum		1.00
	Maximum		4.00
Male	N	Valid	1296
		Missing	3770
	Mean		5.9344
	Std. Deviation		3.67916
	Minimum		1.00
	Maximum		22.00

Figure F-11. FORSCOM APRT Pilot Event – Push Ups (“10%” Point Shown By Arrow)

Male & Female Combined All FORSCOM APRT ACRT

		BMI	Body fat	APFT Push Ups	APFT Sit Ups	APFT 2 Mile run Time	APRT Push Ups	APRT Shuttle	APRT1Minute Rower	APRT 2 Minutes Rower	APRT Long Jump	APRT One and a Half Mile Run Time	ACRT Total Time	Pullups
BMI	Pearson Correlation	1	.760	-.029	-.151	.252	-.030	.076	-.087	-.135	-.045	.297	-.011	-.167
	Sig. (2-tailed)		.000	.038	.000	.000	.025	.000	.000	.000	.001	.000	.435	.000
	N	5493	5493	5219	5218	5215	5428	5205	3437	1999	5392	5430	4675	1296
Body fat	Pearson Correlation	.760	1	-.286	-.153	.494	-.250	.209	-.108	-.185	-.243	.483	.320	-.180
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	5493	5493	5219	5218	5215	5428	5205	3437	1999	5392	5430	4675	1296
APFT Push Ups	Pearson Correlation	-.029	-.286	1	.507	-.507	.602	-.239	.196	.192	.300	-.406	-.397	.435
	Sig. (2-tailed)	.038	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	5219	5219	5251	5248	5242	5207	4998	3234	1979	5181	5208	4540	1278
APFT Sit Ups	Pearson Correlation	-.151	-.153	.507	1	-.404	.309	-.129	.266	.265	.128	-.315	-.204	.298
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	5218	5218	5248	5249	5240	5205	4997	3233	1978	5180	5206	4538	1277
APFT 2 Mile run Time	Pearson Correlation	.252	.494	-.507	-.404	1	-.403	.233	-.191	-.231	-.281	.697	.520	-.277
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000
	N	5215	5215	5242	5240	5247	5203	4995	3236	1973	5177	5204	4538	1276
APRT Push Ups	Pearson Correlation	-.030	-.250	.602	.309	-.403	1	-.251	.337	.313	.324	-.378	-.332	.494
	Sig. (2-tailed)	.025	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000
	N	5428	5428	5207	5205	5203	5462	5228	3456	1998	5411	5450	4642	1266
APRT Shuttle	Pearson Correlation	.076	.209	-.239	-.129	.233	-.251	1	-.170	-.205	-.256	.257	.285	-.133
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000
	N	5205	5205	4998	4997	4995	5228	5238	3419	1813	5223	5226	4521	1181
APRT 1 Minute Rower	Pearson Correlation	-.087	-.108	.196	.266	-.191	.337	-.170	1	.a	.127	-.257	-.180	.a
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.	.000	.000	.000	.
	N	3437	3437	3234	3233	3236	3456	3419	3456	0	3411	3456	2995	0
APRT 2 Minutes Rower	Pearson Correlation	-.135	-.185	.192	.265	-.231	.313	-.205	.a	1	.167	-.287	-.183	.223
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.		.000	.000	.000	.000
	N	1999	1999	1979	1978	1973	1998	1813	0	2013	2009	2000	1650	1263
APRT Long Jump	Pearson Correlation	-.045	-.243	.300	.128	-.281	.324	-.256	.127	.167	1	-.255	-.469	.261
	Sig. (2-tailed)	.001	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000
	N	5392	5392	5181	5180	5177	5411	5223	3411	2009	5426	5413	4638	1266
APRT One and a Half Mile Run Time	Pearson Correlation	.297	.483	-.406	-.315	.697	-.378	.257	-.257	-.287	-.255	1	.516	-.262
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000
	N	5430	5430	5208	5206	5204	5450	5226	3456	2000	5413	5464	4641	1261
ACRT Total Time	Pearson Correlation	-.011	.320	-.397	-.204	.520	-.332	.285	-.180	-.183	-.469	.516	1	-.144
	Sig. (2-tailed)	.435	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000
	N	4675	4675	4540	4538	4538	4642	4521	2995	1650	4638	4641	4703	1297
Pullups	Pearson Correlation	-.167	-.180	.435	.298	-.277	.494	-.133	.a	.223	.261	-.262	-.144	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	
	N	1296	1296	1278	1277	1276	1266	1181	0	1263	1266	1261	1297	1306

Strength of relationship		
	Strong	(-1.0 to -0.5 or 1.0 to 0.5)
	Moderate	(-0.5 to -0.3 or 0.3 to 0.5)
Blank	Weak or none	(-0.3 ro -0.1 or 0.1 to 0.3)

Male All FORSCOM APRT ACRT

		BMI	Body fat	APFT Push Ups	APFT Sit Ups	APFT 2 Mile run Time	APRT Push Ups	APRT Shuttle	APRT1Minute Rower	APRT 2 Minutes Rower	APRT Long Jump	APRT One and a Half Mile Run Time	ACRT Total Time	Pullups
BMI	Pearson Correlation	1	.958	-.103	-.156	.348	-.087	.116	-.086	-.150	-.100	.383	.103	-.172
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	5030	5030	4782	4781	4780	4979	4824	3143	1835	4970	4973	4332	1286
Body fat	Pearson Correlation	.958	1	-.096	-.175	.381	-.079	.128	-.109	-.179	-.106	.391	.132	-.167
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	5030	5030	4782	4781	4780	4979	4824	3143	1835	4970	4973	4332	1286
APFT Push Ups	Pearson Correlation	-.103	-.096	1	.572	-.405	.536	-.165	.204	.178	.185	-.293	-.235	.430
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	4782	4782	4814	4811	4807	4781	4628	2960	1818	4771	4774	4205	1268
APFT Sit Ups	Pearson Correlation	-.156	-.175	.572	1	-.435	.334	-.136	.257	.267	.136	-.324	-.240	.300
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	4781	4781	4811	4812	4805	4779	4627	2959	1817	4770	4772	4203	1267
APFT 2 Mile run Time	Pearson Correlation	.348	.381	-.405	-.435	1	-.296	.161	-.187	-.222	-.171	.641	.401	-.267
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000
	N	4780	4780	4807	4805	4812	4779	4627	2963	1813	4769	4772	4205	1266
APRT Push Ups	Pearson Correlation	-.087	-.079	.536	.334	-.296	1	-.192	.360	.318	.230	-.284	-.191	.489
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000
	N	4979	4979	4781	4779	4779	5013	4852	3162	1843	4998	5002	4308	1256
APRT Shuttle	Pearson Correlation	.116	.128	-.165	-.136	.161	-.192	1	-.175	-.205	-.194	.203	.206	-.128
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000
	N	4824	4824	4628	4627	4627	4852	4857	3159	1692	4844	4846	4214	1173
APRT 1 Minute Rower	Pearson Correlation	-.086	-.109	.204	.257	-.187	.360	-.175	1	.a	.127	-.255	-.216	.a
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.	.000	.000	.000	.
	N	3143	3143	2960	2959	2963	3162	3159	3162	0	3153	3162	2775	0
APRT 2 Minutes Rower	Pearson Correlation	-.150	-.179	.178	.267	-.222	.318	-.205	.a	1	.150	-.264	-.166	.222
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.		.000	.000	.000	.000
	N	1835	1835	1818	1817	1813	1843	1692	0	1849	1845	1837	1532	1253
APRT Long Jump	Pearson Correlation	-.100	-.106	.185	.136	-.171	.230	-.194	.127	.150	1	-.161	-.317	.252
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000
	N	4970	4970	4771	4770	4769	4998	4844	3153	1845	5004	4992	4301	1256
APRT One and a Half Mile Run Time	Pearson Correlation	.383	.391	-.293	-.324	.641	-.284	.203	-.255	-.264	-.161	1	.418	-.252
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000
	N	4973	4973	4774	4772	4772	5002	4846	3162	1837	4992	5007	4303	1251
ACRT Total Time	Pearson Correlation	.103	.132	-.235	-.240	.401	-.191	.206	-.216	-.166	-.317	.418	1	-.132
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000
	N	4332	4332	4205	4203	4205	4308	4214	2775	1532	4301	4303	4360	1287
Pullups	Pearson Correlation	-.172	-.167	.430	.300	-.267	.489	-.128	.a	.222	.252	-.252	-.132	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	
	N	1286	1286	1268	1267	1266	1256	1173	0	1253	1256	1251	1287	1296

Strength of relationship

	Strong	(-1.0 to -0.5 or 1.0 to 0.5)
	Moderate	(-0.5 to -0.3 or 0.3 to 0.5)
Blank	Weak or none	(-0.3 ro -0.1 or 0.1 to 0.3)

Female All FORSCOM APRT ACRT

		BMI	Bodfat	APFT Push Ups	APFT Sit Ups	APFT 2 Mile Run Time	APRT Push Ups	APRT Shuttle	APRT 1 Minute Rower	APRT 2 Minutes Rower	APRT Long Jump	APRT One and a Half Mile Run Time	ACRT Total Time	Pullups
BMI	Pearson Correlation	1	.946	-.058	-.132	.258	-.131	.038	-.139	-.100	-.077	.275	-.114	-.056
	Sig. (2-tailed)		.000	.229	.006	.000	.005	.454	.017	.202	.115	.000	.036	.878
	N	463	463	437	437	435	449	381	294	164	422	457	343	10
Body fat	Pearson Correlation	.946	1	-.045	-.132	.251	-.107	.082	-.171	-.108	-.066	.271	-.095	-.117
	Sig. (2-tailed)	.000		.348	.006	.000	.023	.109	.003	.169	.174	.000	.079	.747
	N	463	463	437	437	435	449	381	294	164	422	457	343	10
APFT Push Ups	Pearson Correlation	-.058	-.045	1	.439	-.352	.400	-.150	.266	.240	.181	-.359	-.180	.448
	Sig. (2-tailed)	.229	.348		.000	.000	.000	.004	.000	.002	.000	.000	.001	.194
	N	437	437	437	437	435	426	370	274	161	410	434	335	10
APFT Sit Ups	Pearson Correlation	-.132	-.132	.439	1	-.470	.314	-.104	.357	.245	.147	-.418	-.235	.360
	Sig. (2-tailed)	.006	.006	.000		.000	.000	.046	.000	.002	.003	.000	.000	.306
	N	437	437	437	437	435	426	370	274	161	410	434	335	10
APFT 2 Mile run Time	Pearson Correlation	.258	.251	-.352	-.470	1	-.337	.172	-.326	-.282	-.194	.697	.403	-.251
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.001	.000	.000	.000	.000	.000	.484
	N	435	435	435	435	435	424	368	273	160	408	432	333	10
APRT Push Ups	Pearson Correlation	-.131	-.107	.400	.314	-.337	1	-.175	.340	.315	.242	-.304	-.124	.800
	Sig. (2-tailed)	.005	.023	.000	.000	.000		.001	.000	.000	.000	.000	.023	.005
	N	449	449	426	426	424	449	376	294	155	413	448	334	10
APRT Shuttle	Pearson Correlation	.038	.082	-.150	-.104	.172	-.175	1	-.149	-.181	-.352	.176	.263	-.362
	Sig. (2-tailed)	.454	.109	.004	.046	.001	.001		.016	.047	.000	.001	.000	.378
	N	381	381	370	370	368	376	381	260	121	379	380	307	8
APRT 1 Minute Rower	Pearson Correlation	-.139	-.171	.266	.357	-.326	.340	-.149	1	.a	.236	-.390	-.273	.a
	Sig. (2-tailed)	.017	.003	.000	.000	.000	.000	.016		.	.000	.000	.000	.
	N	294	294	274	274	273	294	260	294	0	258	294	220	0
APRT 2 Minutes Rower	Pearson Correlation	-.100	-.108	.240	.245	-.282	.315	-.181	.a	1	.193	-.464	-.324	.303
	Sig. (2-tailed)	.202	.169	.002	.002	.000	.000	.047	.		.014	.000	.000	.394
	N	164	164	161	161	160	155	121	0	164	164	163	118	10
APRT Long Jump	Pearson Correlation	-.077	-.066	.181	.147	-.194	.242	-.352	.236	.193	1	-.179	-.281	-.255
	Sig. (2-tailed)	.115	.174	.000	.003	.000	.000	.000	.000	.014		.000	.000	.478
	N	422	422	410	410	408	413	379	258	164	422	421	337	10
APRT One and a Half Mile Run Time	Pearson Correlation	.275	.271	-.359	-.418	.697	-.304	.176	-.390	-.464	-.179	1	.473	-.324
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.001	.000	.000	.000		.000	.361
	N	457	457	434	434	432	448	380	294	163	421	457	338	10
ACRT Total Time	Pearson Correlation	-.114	-.095	-.180	-.235	.403	-.124	.263	-.273	-.324	-.281	.473	1	-.072
	Sig. (2-tailed)	.036	.079	.001	.000	.000	.023	.000	.000	.000	.000	.000		.844
	N	343	343	335	335	333	334	307	220	118	337	338	343	10
Pullups	Pearson Correlation	-.056	-.117	.448	.360	-.251	.800	-.362	.a	.303	-.255	-.324	-.072	1
	Sig. (2-tailed)	.878	.747	.194	.306	.484	.005	.378	.	.394	.478	.361	.844	
	N	10	10	10	10	10	10	8	0	10	10	10	10	10

Strength of relationship		
	Strong	(-1.0 to -0.5 or 1.0 to 0.5)
	Moderate	(-0.5 to -0.3 or 0.3 to 0.5)
Blank	Weak or none	(-0.3 ro -0.1 or 0.1 to 0.3)

APPENDIX J

Analysis of Male and Female APFT Data from 2nd Brigade Combat Team

USAPHC-AIPH IPP (POC Tyson Grier) September – October 2012 background analyses, previously unpublished data from 2nd Brigade Combat Team, 4th Infantry Division used for internal briefing purposes.

If the current APFT were to be gender neutral (e.g., just have one scale for both men and women with an 8%* fail rate), we would want to know how this would affect men and women of different age groups. To determine the percentage of men and women who would fail within these specific age groups, charts were plotted showing the total population compared to either men or women in their specific age group. Tables of injury risk are also included showing that men who perform poorly on the 2 mile run and push-up test were at a higher risk of injury. There were no difference in injury risk for women and the number of push-ups performed. The women in the fastest 2 mile run time group tended to have a lower injury risk compared to the other groups.

Table J-1. Summary of Men and Women Compared to the Total Population Who Would Fail Using an 8% Cut-off Point

Age	% Failed 2-mile run		% Failed Push-ups	
	Women	Men	Women	Men
≤ 25	51%	3%	60%	2%
26-35	55%	5%	60%	3%
36+	44%	11%	62%	7%

* *8% is used since that is the current cut-point applied to gender-specific APFT results* [15]

All Analyses are of Existing survey data obtained from the 4 ID 2BCT

Table J-2. Averages for Men and Women from existing 4 ID 2BCT Initial Survey Data

	Men	Women	Difference
Age	26.8± 6.0	25.8± 5.6	4%
2 Mile Run Time	14.9± 1.7	17.8± 2.2	19%
Push-Ups	66.2± 14.7	38.5± 13.9	72%
Sit-Ups	68.0± 12.8	64.1± 12.2	6%

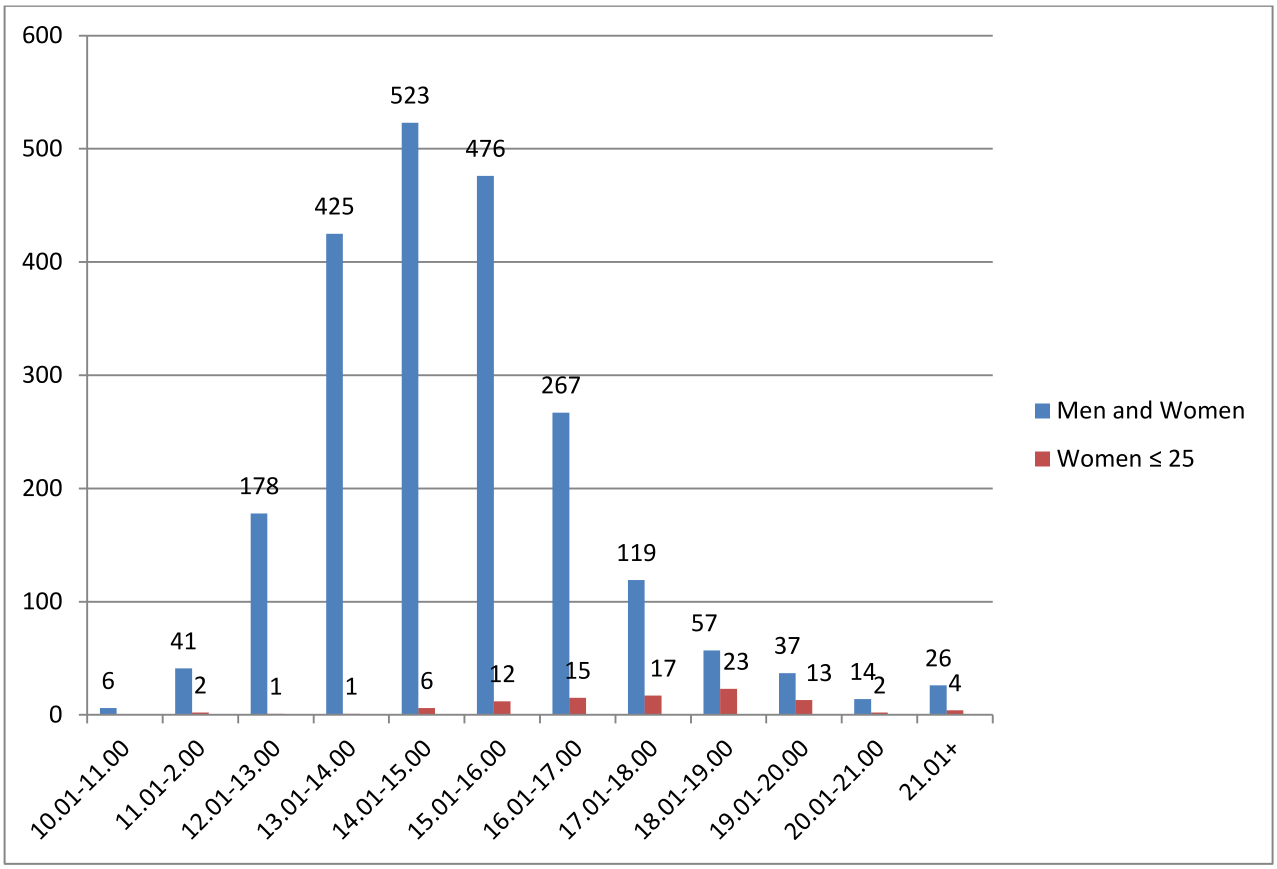


Figure J-1. Two Mile Run Times for Men and Women (n=2169) and Women ≤ 25 years old (n=96)

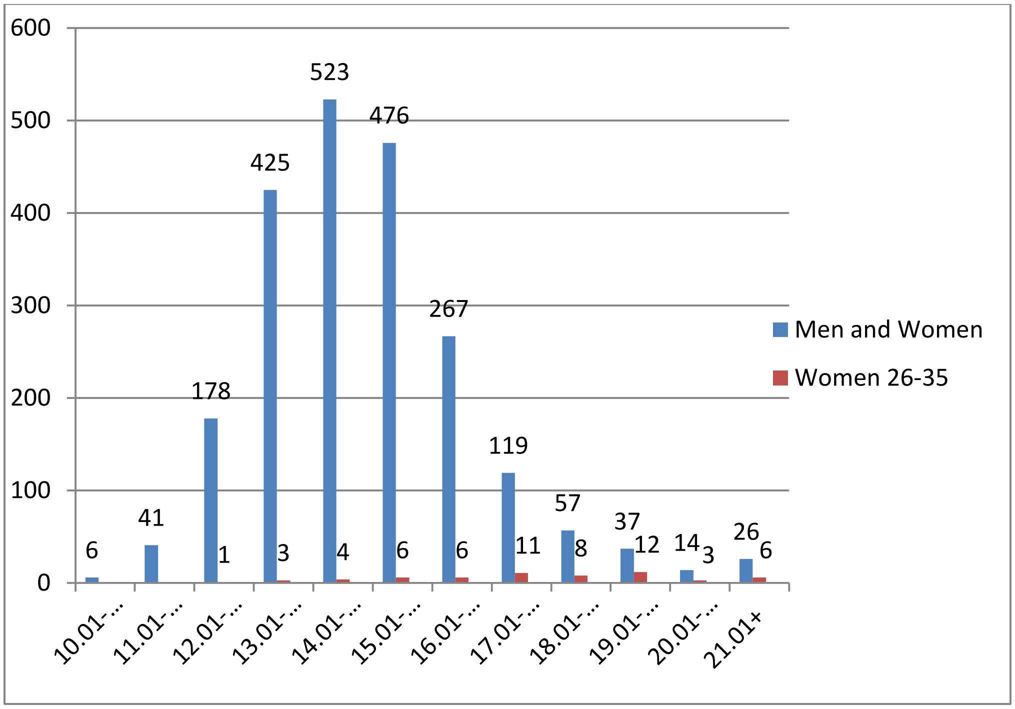


Figure J-2. Two Mile Run Times for Men and Women (n=2169) and Women 26-35 years old (n=60)

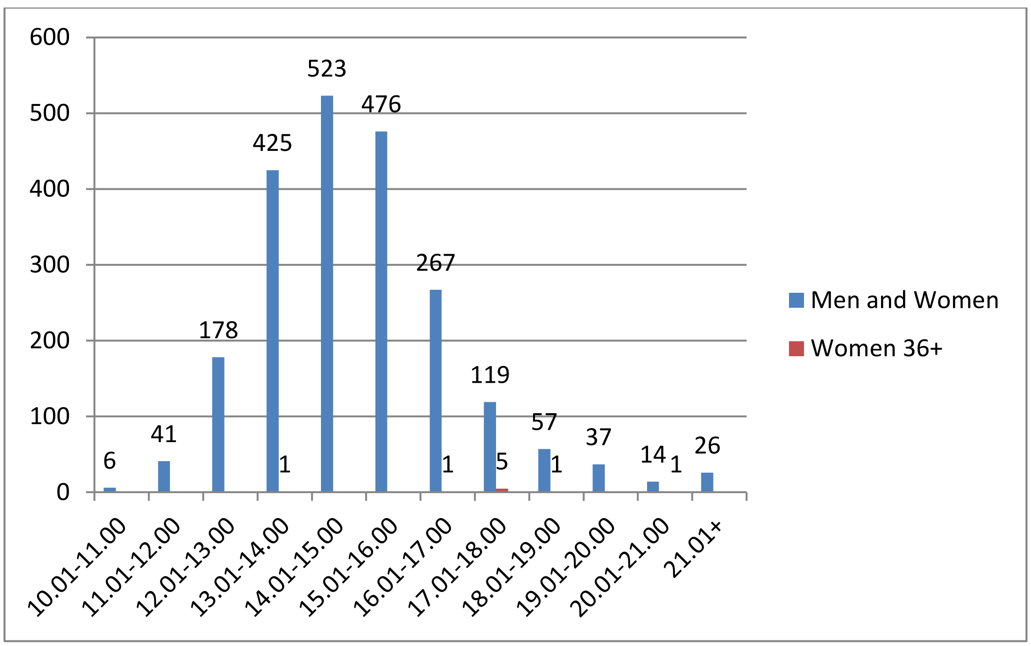


Figure J-3. Two Mile Run Times for Men and Women (n=2169) and Women 36+ years old (n=9)

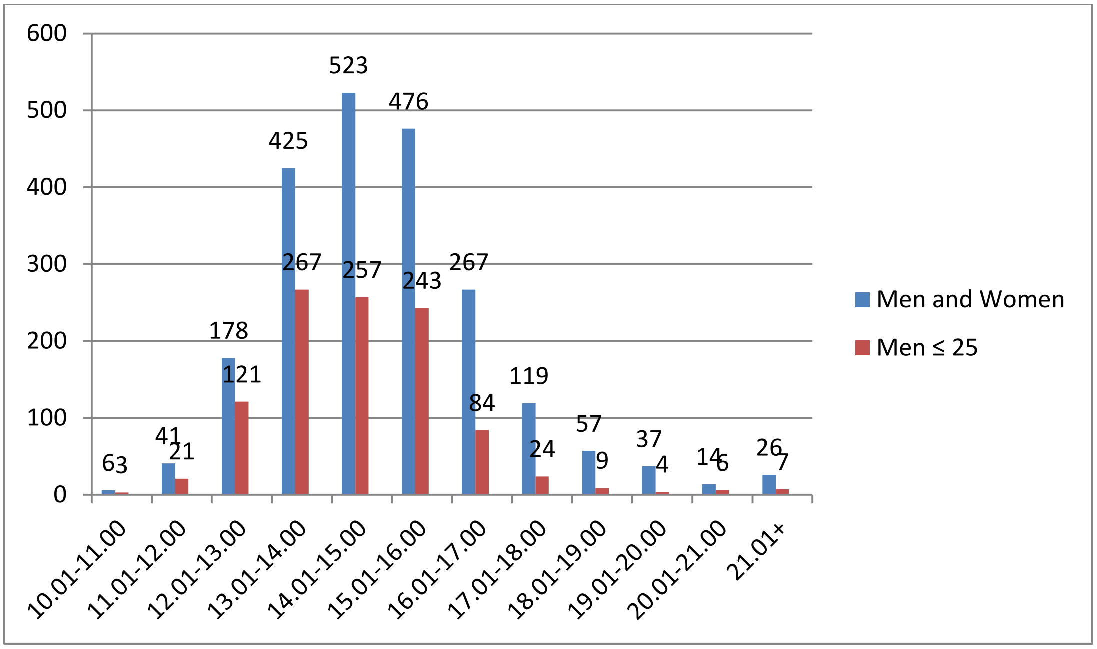


Figure J-4. Two Mile Run Times for Men and Women (n=2169) and Men ≤ 25 years (n=1046)

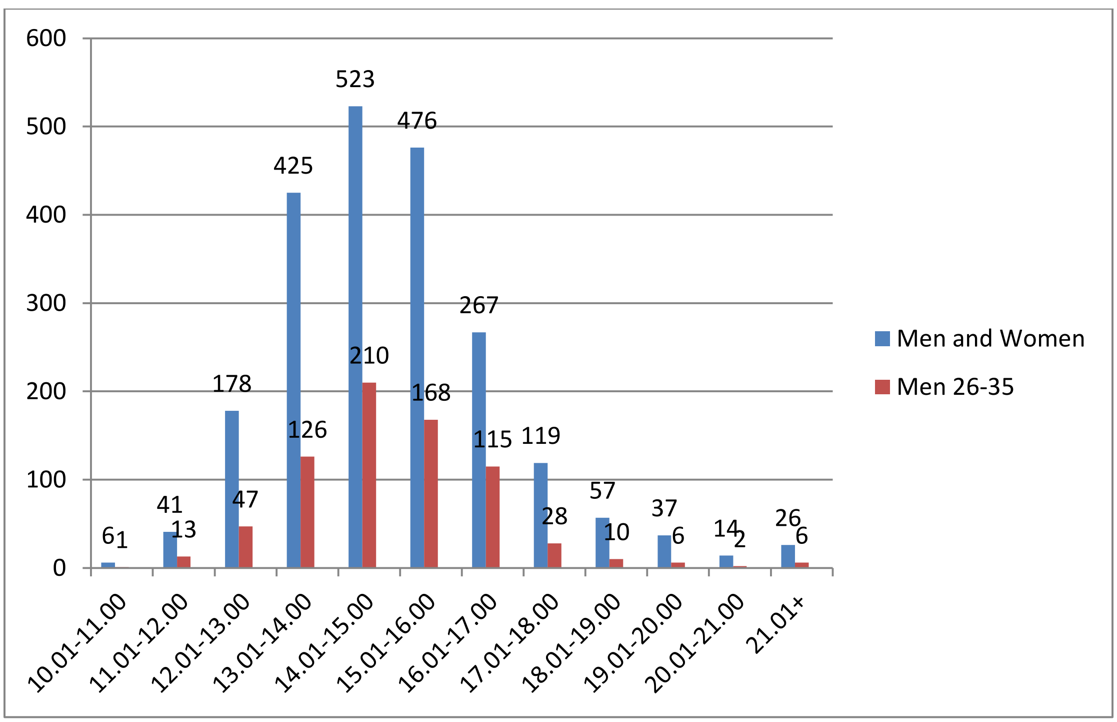


Figure J-5. Two Mile Run Times for Men and Women (n=2169) and Men 26-35 years (n=732)

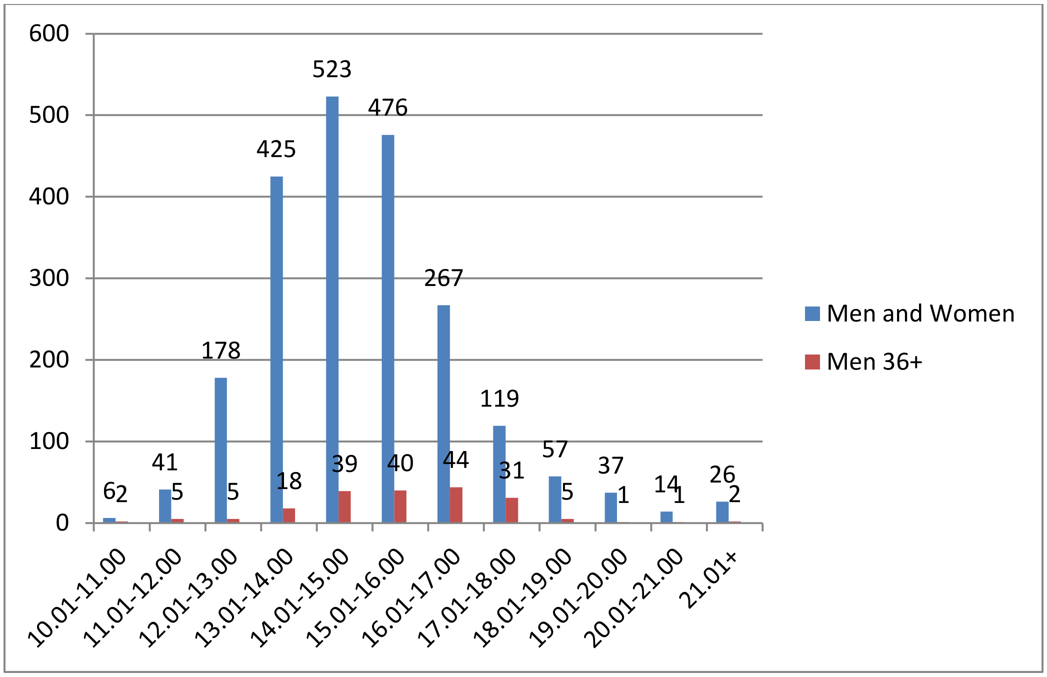


Figure J-6. Two Mile Run Times for Men and Women (n=2169) and Men 36+ years (n=193)

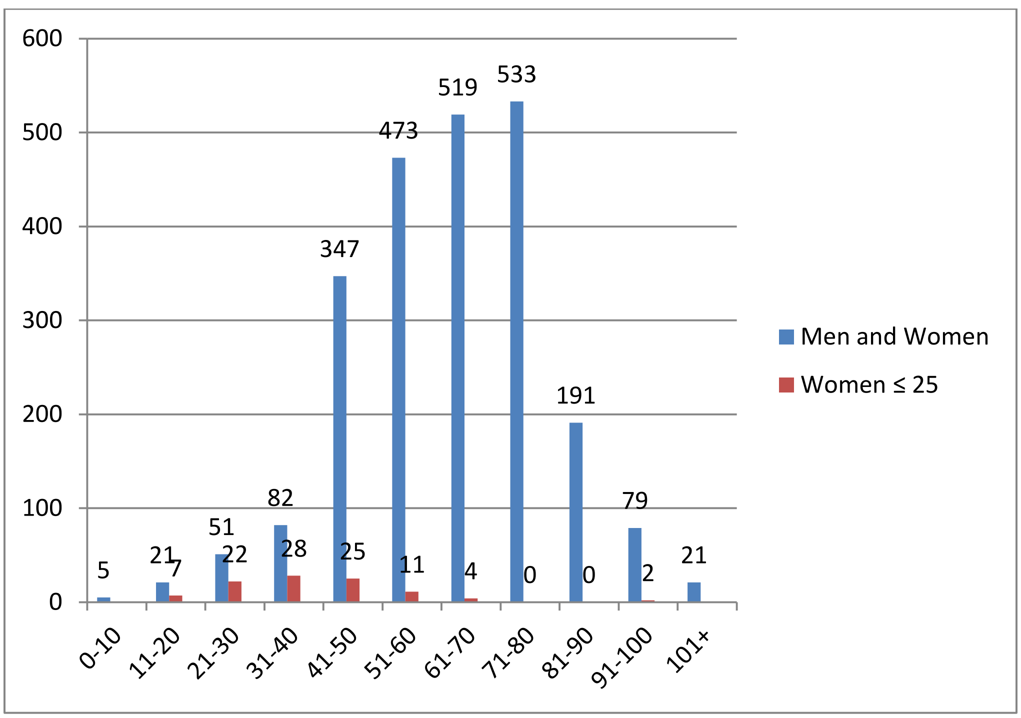


Figure J-7. Push-Ups for Men and Women (n=2322) and Women ≤ 25 years old (n=99)

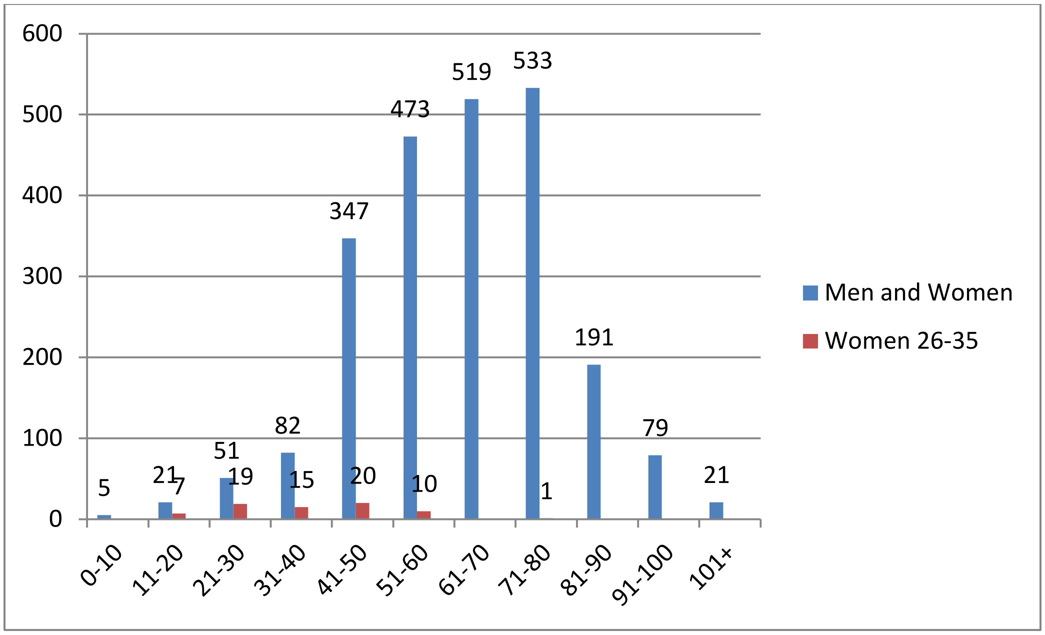


Figure J-8. Push-Ups for Men and Women (n=2322) and Women 26-35 years (n=72)

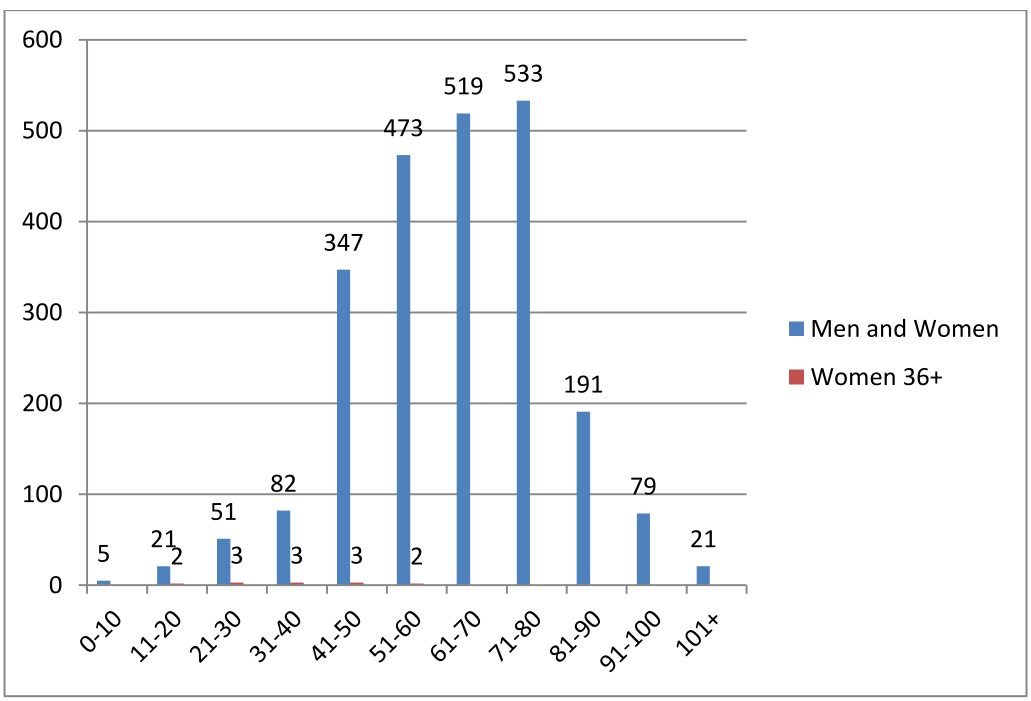


Figure J-9. Push-Ups for Men and Women (n=2322) and Women 36+ years old (n=13)

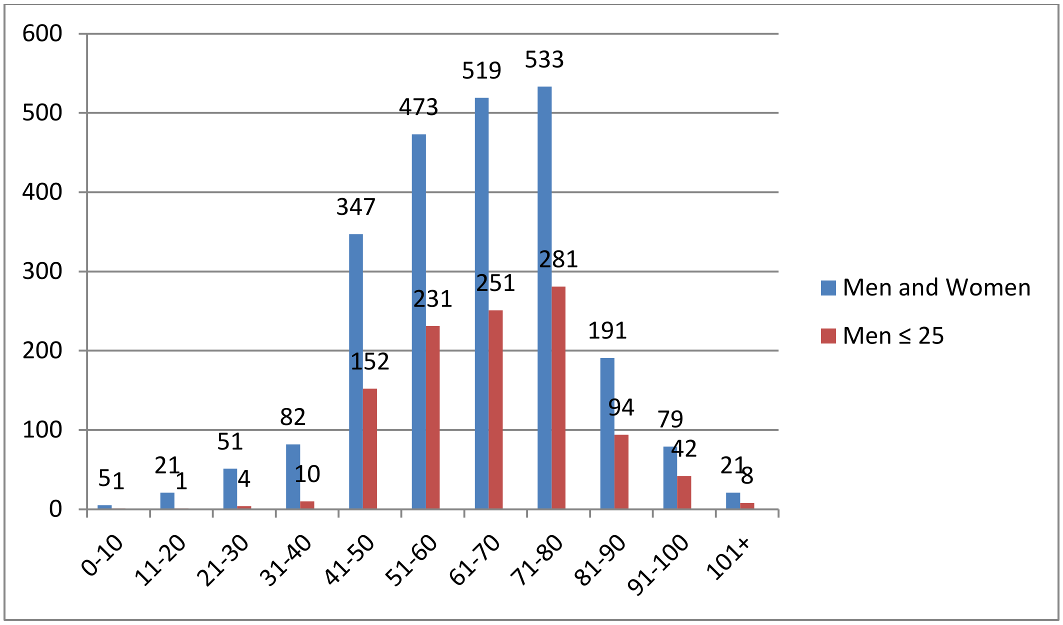


Figure J-10. Push-Ups for Men and Women (n=2322) and Men ≤ 25 years old (n=1075)

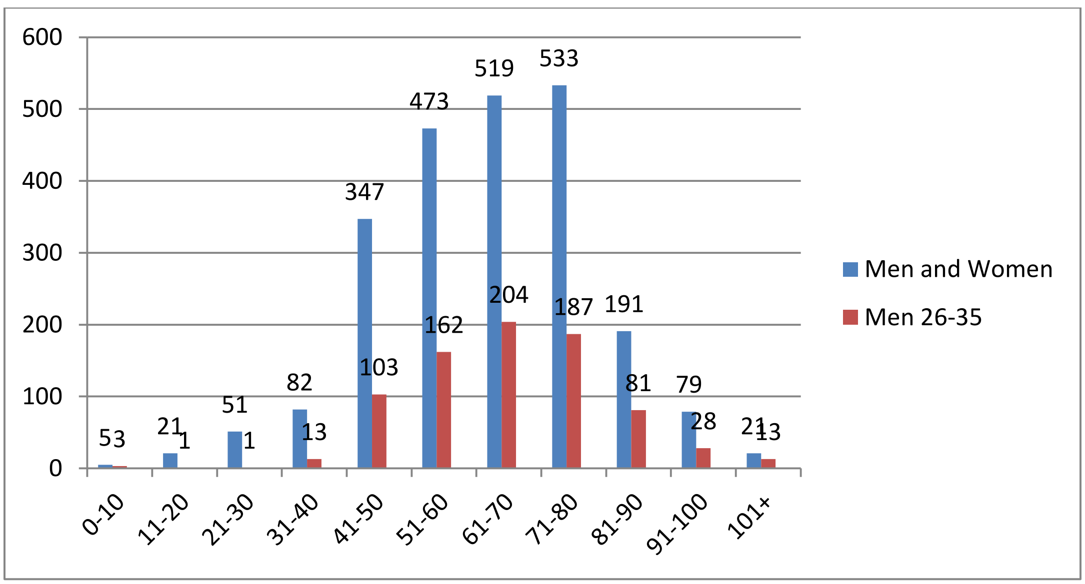


Figure J-11. Push-Ups for Men and Women (n=2322) and Men 26-35 years old (n=796)

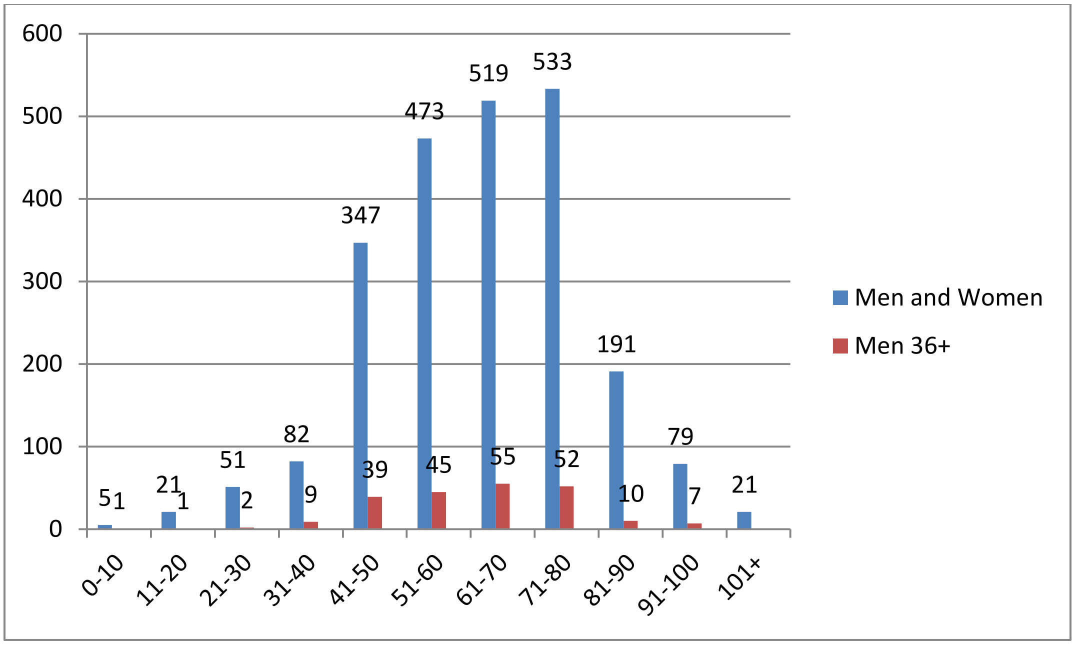


Figure J-12. Push-Ups for Men and Women (n=2322) and Men 36+ years old (n=221)*

Table J-3. Injury Risk and 2 Mile Run Times for Men

Run Time (Minutes and Fraction of a Minute)	n	% Injured	Risk Ratio and 95% CI	p-value
≤ 13.75 min	520	35%	1.00	
13.76-14.67 min	489	36%	1.04 (0.89-1.23)	0.65
14.68-15.75 min	496	41%	1.19 (1.01-1.39)	0.03
15.76+ min	497	44%	1.28 (1.10-1.49)	<0.01

Table J-4. Injury Risk and 2 Mile Run Times for Women

Run Time (Minutes and Fraction of a Minute)	n	% Injured	Risk Ratio and 95% CI	p-value
≤ 16.13 min	42	33%	1.00	
16.14-17.83 min	43	49%	1.47 (0.87-2.48)	0.15
17.84-19.00 min	44	64%	1.91 (1.18-3.09)	<0.01
19.01+ min	42	50%	1.50 (0.89-2.53)	0.12

Table J-5. Injury Risk and Push-Ups for Men

Push-Ups (reps)	n	% Injured	Risk Ratio and 95% CI	p-value
≤ 55	542	49%	1.32 (1.14-1.52)	<0.01
56-66	541	40%	1.10 (0.94-1.28)	0.24
67-76	539	38%	1.02 (0.87-1.19)	0.82
77+	503	37%	1.00	

Table J-6. Injury Risk and Push-Ups for Women

Push-Ups (reps)	n	% Injured	Risk Ratio and 95% CI	p-value
≤ 28	50	58%	1.41 (0.88-2.24)	0.13
29-39	24	55%	1.33 (0.82-2.15)	0.24
40-50	29	46%	1.12 (0.69-1.81)	0.64
51+	14	41%	1.00	